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# Assessment of the best dry port location in Jordan

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**WORLD MARITIME UNIVERSITY**
Malmö, Sweden

# ASSESSMENT OF THE BEST DRY PORT LOCATION IN JORDAN

By

**OMAR SOUD ALETEIWI**
**Jordan**

A dissertation to be submitted to the World Maritime University in partial Fulfilment of the requirements for the award of the degree of

**MASTER OF SCIENCE**
**In**
**MARITIME AFFAIRS**

**SHIPPING MANAGEMENT AND LOGISTICS**

2017

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## DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me. The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

Signature: *Omar Aleteiwi*

Date: *19 Sep 2017*

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Institution/organization:

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In the name of Allah; the Gracious, the Merciful

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## ABSTRACT

Title of Dissertation: **Assessment of the Best Location of Dry Port in Jordan**

Degree: **MSc**

This dissertation is a study to find and evaluate the best location of the dry port in Jordan. A study like this is very important to Jordan and other countries who have intention to set up a dry port as it shows where the best location that saves time and money is. Furthermore, it is considered very valuable as it enhances the literature and current research with more evidence and analyses using the center of gravity model approach and distance and cost saving analyses. Moreover, it discusses and explains the importance of the dry port and the impact of having it in the best location.

A literature review have been conducted on topics related to the dry port and the mechanism of selecting the appropriate location. In addition, some reports and studies related to the dry port which intended to be established in Jordan have been analyzed. Then, the present and the future transport and logistics sectors in Jordan have been evaluated and analyzed. Following is a discussion of the problems that facing these sectors has been ended up in offering some solutions which include the establishment of the dry port. The impact and benefits of the dry port were discussed and then the Center of Gravity Model was applied to find the best location for the dry port.

Jordanian government proposed several location to set up the dry port in it, a comparison between these locations was made, through this comparison, the time and cost saving that will be provided by setting up the dry port in the location that obtained from the application of the Center of the Model was clarified and discussed. Then, the advantage and disadvantages of this location were further analyzed and the economic impact of the project was elaborated.

Before the end of the study, a recommended functionality and design of the sought dry port were offered according to the literature and the worldwide standard of building for building a dry port. Finally, some recommendations were reached and discussed.



**Keywords: Dry port, Best location, Impact, Transport,**

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| | |
|---|---|
| **ACT** | Aqaba Container Terminal |
| **ADC** | Aqaba Development Corporation |
| **APMC** | Aqaba Port Management Company |
| **APM** | A.P. Moller–Maersk Group |
| **ASEZA** | Aqaba Special Economic Zone Authority |
| **EDI** | Electronic Data Interchange |
| **GDP** | Gross Domestic Product |
| **GPS** | Global Positioning System |
| **IFC** | International Finance Corporation |
| **JOD** | Jordanian Dinar |
| **Km** | Kilo meter |
| **KPIs** | key performance indicators |
| **LPI** | The Logistics Performance Index |
| **MEA** | Middle East Area |
| **MoT** | Ministry of Transport |
| **NSW** | National Single Window |
| **NAFITH** | National Freight Information and Transportation Hub |
| **RoRo** | Roll-on/Roll-off Ships |
| **TCS** | Truck Control System |
| **TEUs** | Twenty-foot Equivalent Units |
| **TRB** | Transportation Research Board |
| **UNCTAD** | United Nations Conference on Trade and Development |
| **UNECE** | United Nations Economic Commission for Europe |

# Chapter 1: Introduction

## 1.1. Introduction

Logistics is considered a very important factor for land, air and maritime transport. Therefore, countries need to manage well their logistics i.e. flow and storage of goods, services, related information, intelligence throughout the trade transport process from the origin to the final consumption. However, the poor coordination and organization of logistics and supply chain management, such as problems within storage, warehousing, transportation, distribution problems, customs, border crossings, and regulation would hinder trade processes and deteriorate the country's competitiveness.

Hence, when there are problems within the country's logistics and transportation, its port may suffer from transport congestions and long dwell time. Also, the port may lose its customers such as big shipping lines and important tramp shipping companies, and shippers which may turn to other ports that are more efficient, faster and offer an uninterrupted cargo handling and customs clearance. Thus, suitable way to reduce congestion and the total cost of import and export, to increases the port competitiveness and to further streamline trade should be found.

In Jordan, the total cost of transport and logistics is considered high, thus that makes shippers utilize other options for import and export. In addition, there are many agencies involved in the transport and export process in Jordan; customs clearance time is high and border crossing have a long truck waiting time. Consequently, customers may import and export cargo through Israel (from Haifa Port, then by truck through Israel to Jordan) or Syria seeking less time and cost. Moreover, the cargo that may cross the Suez Canal can have Jordan as a transit option if the transport is efficient with low cost, but it is not. Moreover, Jordan is a gateway to Iraq and other neighboring countries (transit cargo amounts to 30% of import cargo), so the problems would lead these countries to defect to other suitable and low-cost corridors.

Therefore, there is a need for solutions in shape of projects that could be as part of a bold initiative. The goal of this initiative is to link the port and the primary cargo distribution facilities (Aqaba, Amman, Ma'an, Zarqa, and Mafraq) and warehouses through the local and regional network of roads and planned railways. That is to confirm the fast and efficient transport of goods and containers from or to Aqaba Port to downsize the congestion and the dwell time at the Aqaba Container Terminal (ACT) and improve the logistical competence.

Hence, the Jordanian government started working on plans and conducted feasibility studies for having an inland container depot, a dry port, a logistics center, a port extension, and maintenance of infrastructure. The dry port seemed a good idea because it contains many solutions within its design and function. For example, it has the customs and other agencies in the same site, which lowers the time of clearance, and it decreases the congestion at the port and streamlines the transit cargo using multimodal transportation. A dry port enhances both logistics and transport sectors. The possible estimated impacts could be as follows:

- Reduction of inland transport travel time for cargo carriage (use of multimodal transportation);
- Decrease of the transport and trade costs;
- Advantage and returns from the cost saved;
- Stimulation of productivity for ports and customs;
- Increase of local production due to the ease of doing business;
- Reduction of inventory cost because of the reliability of the domestic supply chain and timeliness of delivery;
- Extension of hinterland and improvement in access to remote markets;
- Rise in demand for services and goods;
- Increase in direct foreign investment;
- Industrialization promotion;
- Provision of jobs and work opportunities.

## 1.2. Jordanian Dry Port Feasibility Study

Jordan has made a couple of studies that aimed at studying the feasibility of building a dry port. One prominent study, which was published in 2012, was conducted by the Maritime and Transport Business Solutions (MTBS) in the Netherland (MTBS, 2012) titled Studies for Dry Ports / Logistics Centers in the Hashemite Kingdom of Jordan. The study went with the Jordanian recommendation that offered three locations for the desired dry port, namely Aqaba (the port city, South), Amman (the capital, North/Middle), and Mafraq (Northern Jordan).

The study has conducted a demand assessment for the three locations. However, the study did not tackle other important factors that should be considered once a dry port is built. A case in a point is the issue of the best location in Jordan for the dry port because there might be a better location than the three proposed ones. A further issue in the report is that the main factor of studying the feasibility was the demand assessment, which was dependent on a projection of the Jordanian GDP. However, the GDP was slightly disrupted by the neighboring crisis in Iraq and Syria. Moreover, the study did not take into account the transit cargo that might be a potential traffic increase for the proposed dry port. In brief, the report stated that the three proposed locations are considered feasible. However, the government has not taken the decision to choose the location of the dry port yet. Moreover, the Alghad Newspaper stated that Aqaba Development Corporation (ADC) intends to build a dry port in a different location (Ma'an City/ South Jordan) (Alghad Newspaper, 2017). Obviously, there seems to be an issue of choosing the best location for a dry port in Jordan. Moreover, it is known that the dry port will develop the surrounding area and will create employment opportunities for people close to it. These and other reasons related to the development of the governorate led to a strong competition between the governorates of the Kingdom to embrace the dry port in it, which led to the confusion of the Jordanian government in choosing the appropriate location for the establishment of this dry port. So, with disregard to the cost of the dry port, as the owner of the project and the land is the Jordanian government. It is assumed that the cost of the project will be similar in all places, Therefore, the best place to establish this project in a practical way will be found in order to save time and cost to the consumer. This will lead to increased competition with neighboring ports, especially Haifa Port, which has a distinguished geographic location

where the goods exported or imported do not need to pass through the Suez Canal, which means saving time and money. As in 2003 the ACT lost some of the shippers for the benefit of the Haifa Port due to the congestion problem. Furthermore, in 2014 some of the shippers shifted to Haifa Port again due to the length of the cargo handling and the high fees that are imposed on the shipper ("Jordanian Traders Shift," 2014).

In this dissertation, more envisioning facts about building a dry port in Jordan will be discussed. However, first the study will look at the problems within the Jordanian logistics and transport sector, then, recommend solutions, and if the dry port is a possible solution. The study will analyze the traffic of the Aqaba Container Terminal (ACT) and then find the best location of the dry port in Jordan taking into account all the local markets and production centers using the center of gravity model. Further, the study will shed light on the distance and cost saved if the dry port is built at the recommended location with a comparison to the other proposed dry port locations.

### 1.3. Aim of the study

This research aims to analyze the importance of a dry port to Jordan, as well as addressing the logistics and transport problems and offer solutions. In addition, the research will assess the best location of the dry port and compare it to proposed locations in Jordan. Moreover, the research will have a recommendation for the dry port design and functionality.

### 1.4. Objectives of the study

This research endeavors to achieve a couple of objectives, which could be summarized as follows:

1. To discuss the reasons why a dry port is required in Jordan.
2. To address applicable solutions for problems in the logistics and transport sectors in Jordan and in import and export via Aqaba Seaport.
3. To assess the best location of dry port in Jordan compared to other proposed locations.
4. To set up recommended functionality and design of the dry port in Jordan.

## 1.4. Literature review

A dry port is a port situated in the hinterland servicing an industrial / commercial region connected with one or several ports with train or road transport and is offering specialized services between the dry port and the overseas destinations. Normally, the dry port is container and multimodal oriented and has all logistics services and facilities, which are needed for shipping and forwarding agents (FDT, 2007).

The literature has covered a wide variety of research that tackled the issue of a dry port and an inland logistics center concerning the functionality, operation, policies, feasibility study, cost benefit analysis, network analysis, and other related measures. The dry port concept is surely not new, and the role and spatial coverage of the seaport is discussed by many researchers, for example by Heaver, 2000 and 2001; Notteboom, 2002; Notteboom and Winkelmans, 2001; Robinson, 2002; Klink and Berg, 1998.

In a study about network in the Baltic region by Integrating Logistics Center (2009), it stated the aspects that concern the area where a dry port would be developed, namely the type of facilities that costumers will require, the initial volume of goods and estimated volumes for a ten-year horizon. With respect to the second and the third aspects, such analysis can be conducted by analyzing the present structure (volume of goods) and then, based on the result from the previous years, a projection of how the future estimated volumes of goods would be conducted. It is very important to analyze the amount of goods at the present time, as well as making an estimate of the future amount of goods passing through the country, either domestic or transit, to find out whether there could be or already is a necessity for building or developing a dry port.

Beresford and Dubey (1990) listed the factors that should be taken into consideration for the location of a dry port, those factors are:

- Traffic flows between centers of production, consumption and the ports.
- Transport infrastructure in the vicinity of the site.
- Modes of transport available and network capacities.
- Existing auxiliary transport related services in the vicinity of the site.
- Possible reduction in tonne-km by road transport with the introduction of the dry port.

- The actual functions of the dry port, such as road haulage, stuffed and empty container storage, shunting, customs clearance etc.
- Scope for future site expansion.

Dry ports are beneficial and have many advantages, such as sorting out congestions problem at ports and port cities as it would relieve the cities from congestions, and make the cargo handling more efficient providing a wide range of logistics solutions to customers in the hinterland of the port. According to Notteboom and Winkelmans (2001), dry ports shift the flow of cargo (big volumes) from the typical roads into more energy efficient transport modes, which causes less harm to the environment.

Importantly, after the implementation of a dry port, there are major savings in time and financial spending by avoiding the long queues outside and inside the port and by moving the containers to the dry port smoothly. Obviously, that kind of expansion results in bringing new customers and it yields more profit triggering and boasting the whole regional economy.

Moreover, many studies discussed the feasibility of the implementation of a dry port in the hinterland of seaports, such as the case of Roso and Lumsden's research (2009), which analyzed and compared the physical and administrative flow in a seaport from the time standpoint with or without a dry port. It concluded that setting up a dry port increases the seaport's terminal capacity and that eventually squares away the issue of the lack of spaces at ports. On the other hand, a port that does not lack spaces at the terminals will not benefit from shifting the storage (warehouses and storing facilities) to a hinterland dry port, conversely, that would cause a loss in the overall port profitability.

The rationale of the dry port is about connecting the seaport by rail to intermodal terminals (dry port) where the shippers can deliver or pickup (load/unload) their cargo, most of the time containers, similar to the process done in the seaport (Roso & Lumsden, 2009).

The motivation for establishing a dry port and investigating the whole network is clear and stated by many experts. As stated by Cullinane and Khanna (2000), it yields a productive system for regional and local networks, and it provides better solutions in terms of logistics,

warehousing issues, and transportation. Eventually, this restrains the growing costs of transport and controls the industrial productivity competitiveness.

Mourão, Pato and Paixao (2002) agreed and argued that ports compete not only in terms of transshipment efficiency and tariffs but also in terms of speed and reliability of shipments to their destinations. Because of the growing containerized transport, seaports face serious problems, such as lack of space at the terminals and increased landside transport bottlenecks. Indeed, for some ports, the problem emerges from the gates to the hinterland, where roads get congested, jammed, and insufficient road connections lead to delays in delivery and increase in transport costs i.e. leading to significant cost and time problems. Obviously, port expansion, by building a dry port, leads to having new markets, and that improves the seaport's access to areas outside its traditional hinterland, making new customers, generating more profit and promoting the regional economic activity (Roso & Lumsden, 2009).

Therefore, strategic decisions need to be implemented which utilize the railways and improve the intermodal transport. It has been suggested that building a dry port would relieve port problems especially those coming from the hinterland. Various countries applied the concept of the dry port worldwide. According to Mande (2000), the Isaka facility (Isaka Dry Port in Tanzania) is very profitable because of the increasing exchange of containers with neighboring land-locked countries such as Rwanda and Burundi.

From the previous literature review, it is clear that a dry port has advantages and is useful for the countries where needed. Hence, Jordan is one of the countries that always endeavors to improve its trade, import, and export facilitation, logistics and transport sector either nationally or regionally to neighboring countries. Therefore, the dry port concept in Jordan seems a very attractive idea to boost ports productivity, facilitate trade, abolish problems in the logistics and transport sector. In this way, dry ports cut down import and export costs and manage the delivery of the products in easier ways. Moreover, dry ports reinforce multimodal solutions that shun traffic bottlenecks.

### 1.6. Methodology

This dissertation attempts in the beginning to study the status of the transport and logistics sectors in Jordan and import and export issues. It will analyze the current traffic of ACT,

then exploit the root cause of the problems. After that, solutions will be offered and suggestions and recommendation made to sort out the underlying problems. The dry port location is going to be defined through a center of gravity model.

The center of gravity model is very popular for finding the economic benefit of projects and the best location of facilities that save time and cost (Anderson, 2016; Rosenberg, 2011). It has been proven to be the most generally beneficial empirical model for understanding the distribution of goods and factors of production (the distribution of economic flows between origins and destinations, one based on the demand side and the other on the supply side and one based on the individual actor transferring the goods ( James, 2010).

In this research, it is aspired to locate the best location for the dry port that would serve the whole country, create more traffic, lower and save costs of transport and logistics, facilitate the transactions and deals of shippers and regulators.

Moreover, a comparison (time, distance and cost) among the previously proposed location is analyzed to augment the best location of a dry port offered by this research.

### 1.7. Structure of the study

The structure of the dissertation will attempt to fulfil the sought objectives of this research. Therefore, it will cover logistics and transport problems in Jordan so as to find solutions and recommendations for the government and to contribute more to academic research. The structure (see Figure 1) will be as follows:

- Chapter one **(Introduction**): This chapter consists of:
    - Introduction: It explains consequences of poor logistics and transport, the dry port and it is role in general context and the benefits of having a dry port in Jordan.
    - Jordanian Dry Port feasibility Study: It sheds light on the proposed dry port location in Jordan too.
    - Aim of the study: It states why the researcher want to conduct this study
    - Objective of the study: What the researcher wants to achieve throughout the study.

- Literature review: Previous studies and most popular researchers' views and opinions about the dry port concept.
- Methodology: How the researcher wants to conduct the research, what is the research design and approach including the methods that are going to be used.
- Structure of the study: brief explanation about chapter content.

- Chapter Two (**Jordanian Transport and Logistics**): this chapter contains:
  - Status of Jordanian ports, transport, and logistics: it covers the ports in Jordan, the transport used inland to carry the freight, and the logistics sector. Also, it sheds light on the future development plans.
- Chapter Three (**Logistics and Transport Sector Problems and Solutions**): In this chapter the following will be discussed:
  - Root cause for the lack of competitiveness of Jordanian import and export: this section digs deep to find the root cause of the problems that weaken Jordanian trade by looking at problems in logistics performance and cost, ports problems, volume and value of seaborne trade, logistics problems.
  - Solutions for current problems in transport and logistics: This section discusses the available and applicable solutions to address and sort out the problems that were found in chapter two.
  - Custom Yard (Yard number Four) as Case Study, which has benefits and it is analyzed as an example of reformation within the logistics sector.
- Chapter Four (**Dry Port as Possible Solution with Assessment of the Best Location**): we in this chapter will study the following:
  - Center of gravity model: this section applies the center of gravity as a quantitative method to find the best location of the dry port in Jordan.
  - Cost, time and distance savings: In this section, the time, distance and costs saved on average are calculated and compared to the other proposed locations.
  - Dry port design and functionality: This section, recommends an inclusive dry port functionality and design
- Chapter Five (**Conclusion**): This chapter provides:

- Summary: This section summarizes and conclude the result of this study and
- Implication and further areas of research: This section explains the implications of this study and sheds light on further areas of research with respect to building dry port in Jordan.
- References: This section lists the cited reference throughout the whole study.
- Annexes: This is where a detailed calculation of the center of gravity model will be explained.

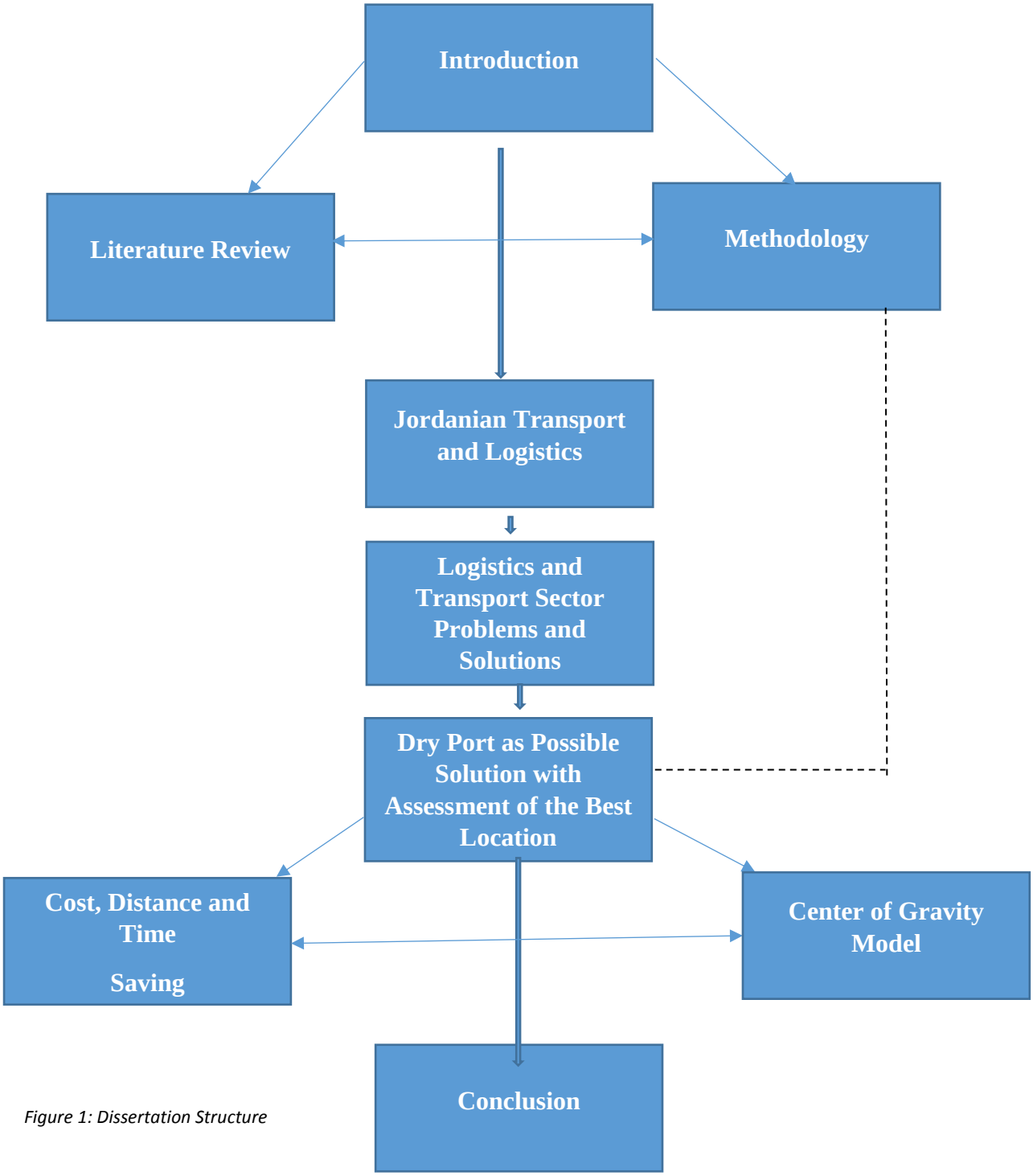


*Figure 1: Dissertation Structure*

## Chapter Two: Jordanian Transport and Logistics

Jordanian transport and logistics are the backbone for the Jordanian trade. Although the transport sector has a good infrastructure and an enough workforce, it suffers from various weaknesses and potential threats to advancement (MoP, 2014b). Jordan seeks to provide modern infrastructure, improve and enhance the competitiveness of the country while restructuring the public sector to become more productive and effective. However, there are some problems that hinder the progress and efficiency of logistics sectors. Therefore, to have a wide picture of the transport and logistics sectors, the status of those sectors will be described and the underlying problems identified

### 2.1. Port and Transport Status in Jordan

Jordan is located in a unique location, (see Figure 2), which serves national and international corridors, such as neighboring countries: Syria, Iraq, Saudi Arabia, Israel, Egypt, and Palestine. The transport sector transfers goods and passengers utilizing the land and air transport, railways, and maritime space of Aqaba ports.


Figure 2: Jordan Location in the Middle East *Source: (MoT,2017)*

The infrastructure of the transport sector in Jordan is as follows, according to the MoT (2017):

- Aqaba Port at the Northern part of the Red Sea.
- Two Railways:
    - Aqaba Railway Corporation (ARC) that transports phosphate and other mineral products from mines near to Ma'an city to the south to Aqaba Port.
    - Jordanian Hijazi Railway Corporation (JHRC) that is mainly used for transporting passengers from Jordan to Syria at the northern part of Jordan.
- Road Network that is spread all around the country and classified as primary, secondary and small village roads. Further explanation is provided at the road network section in this chapter.
- Three international airports; Queen Alia International Airport (Amman), Amman International Airport (Amman), King Hussein International (Aqaba).

### 2.1.1. Road Transport

The main way of transport of cargo in Jordan is trucking services, and the containerized cargo fully use the truck services (100%). The trucking fleet in Jordan is 16,086 trucks (freight transport) owned by 220 companies (MoT, 2016). Trucks that enter Aqaba city heading to the port are controlled by a truck control system that regulates its flow in and out. This system utilizes marshalling yards, checkpoints, entry and exit points, and permits for entry, GPS and internet booking services.

However, it is hard to make an investment to replace the fleet, as most of the fleet is more than ten years old. Thus, this increases maintenance costs and decreases the profitability. Moreover, around 40% of the trucks move empty owing to the imbalance of trade in Jordan. Obviously, there is an excess capacity of truck supply, and there are several safety measures that are compromised within the trucking service (MoT, 2014b).

### 2.1.1.1. Road Network

According to MoT (2014), regarding the road network, it is divided into three major road transport corridors: the North-South-Central corridor (connect Jordan with Syria and Saudi Arabia), Western Border Corridor (connects Syrian border to Aqaba), and the Eastern Corridor (branch from the Central, connecting Ma'an to the Iraqi border). The profoundly used trucking routes in Jordan are from Aqaba to Amman or the free zone in Zarqa. Therefore, this makes Aqaba have the highest density of trucks in Jordan.

The road network in Jordan, as shown in Figure 3, connects Jordan cities together and nationally to neighboring countries.

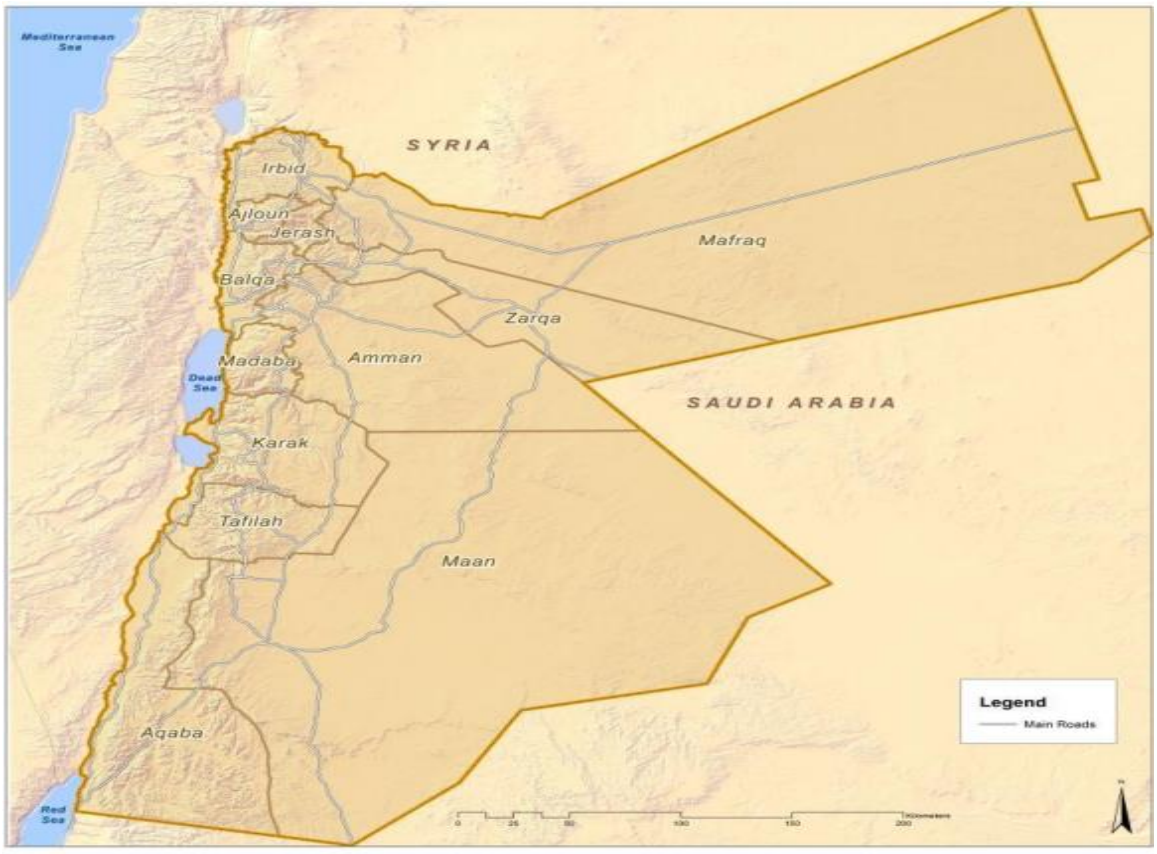


Figure 3: Jordan Roads Network *Resource: (MoT, 2017)*

The road network in Jordan is 7,130 kilometers of roads, including around 3,400 kilometers classified as main roads, 2,050 km are secondary roads, and 2,270 km are village roads

By recent investment, Jordan created 1,700km of highways; one extends from north to south including the desert highway that links Amman with Aqaba, and the other extends from West to East, connecting Zarqa city with the Iraqi and Saudi borders (MoT, 2017). These highways are used by trucks to transport the domestic and transit containers, either 20 TEUs or 40 TEUs. Hence, the Ministry of Transport always attempts to keep the maintenance of the highways in good shape due to the pressure created by trucks. However, due to the high maintenance cost, the maintenance is always late or not sufficient (MoT, 2014b).

### 2.1.2. Border Crossings

Jordan is connected with neighboring countries by ten land border crossings as shown in Figure 4, which are used for the movement of passengers and goods to and from these countries. According to customs statistics for 2013 (Jordanian Customs, 2016), the border with Iraq has the highest traffic flow (almost 70% of transit cargo destined for Iraq) followed by Saudi Arabia then Israel. Table 1 shows the names of these borders including the number of trucks crossing these borders.

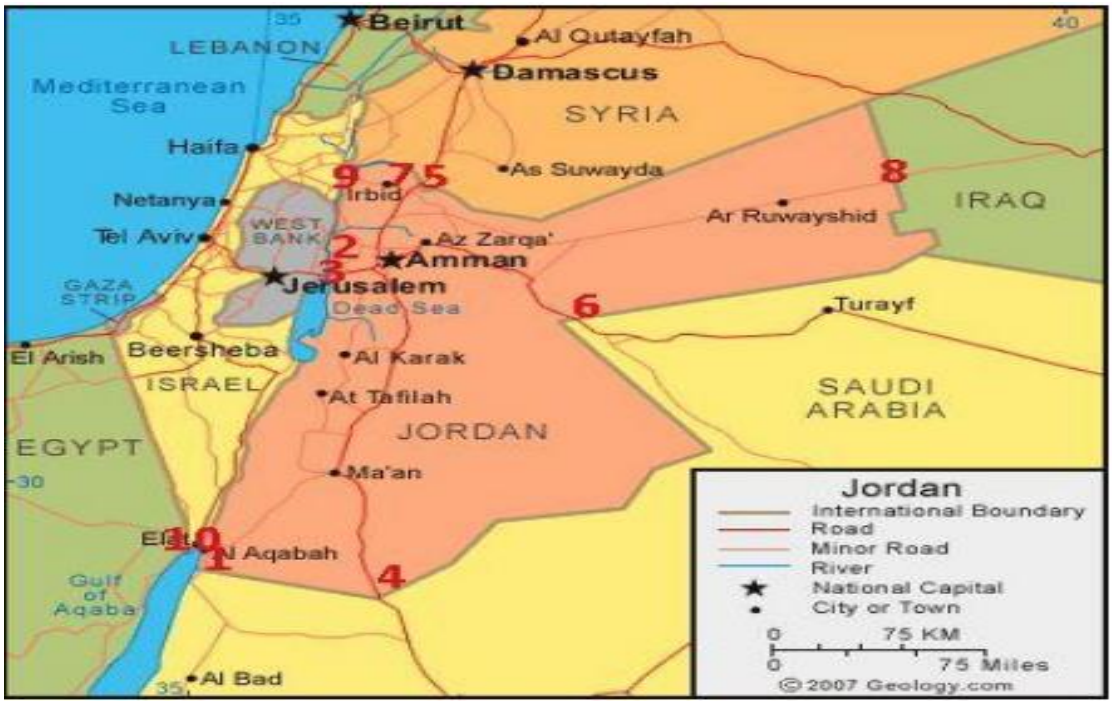


*Figure 4: Border Crossing in Jordan* *Resource: (MoT, 2014a)*

Table 1: Border Crossings with outbound and inbound Trucks and goods (TEUs)

| | Border crossing | Location | Neighboring country | Inbound | | Outbound | |
|---|---|---|---|---|---|---|---|
| | | | | Trucks | TEUs | Trucks | TEUs |
| 1 | Durra Border Center | south of Aqaba | Saudi Arabia | 1,000 | 800 | 920 | 900 |
| 2 | Prince Mohammad Bridge | Deir Alla | Palestine | ------- | ------ | ------ | ------ |
| 3 | King Hussien Bridge | Shouneh Janobieh | Palestine | -------- | ------ | ------ | ------- |
| 4 | Modawarah Border Center | Modawarah | Saudi Arabia | 18,108 | 17000 | 27,568 | 22,000 |
| 5 | Jaber Border Center | Sama Al Serhan | Syria | 44,759 | 36,548 | 43,927 | 40,822 |
| 6 | Al E'mari Border Center | Alazraq | Saudi Arabia | 160,148 | 144,258 | 168,837 | 155,213 |
| 7 | Ramtha Border Center | Ramtha | Ramtha Border Center | ------- | ------ | ------ | ------ |
| 8 | Karameh Border Center | Alrwaished | Iraq | 173,788 | 170,254 | 178,573 | 140,587 |
| 9 | Northern Crossing | Shouneh Shamalieh | Israel | ----- | ------- | ------ | ------ |
| 10 | Southern Crossing | Wadi Araba | Israel | 25,206 | 22,521 | 23,534 | 22,582 |

*Source: (Jordanian Customs, 2016)*

### 2.1.3. Railway Network

The available railway network in Jordan is 620 km/ narrow gauge track. These tracks are operated by Aqaba Railway Company (ARC) and Jordanian Hijazi Railway Corporation (JHRC). The only operational and useful lines are ARC that transfers minerals from mines (Alshaydiah) to Aqaba port on tracks within a 293 km range. The ARC railway carries phosphate, phosphoric acid, and sulfur from Alshaydiah Mines. The mines produce approximately 10 million tons each year (MoT, 2017).

#### 2.1.3.1. Railway Development

Although the railways play a limited share in the Jordanian transportation sector, the Ministry of Transport (MoT) is considering new regulatory and legislative development in terms of having an independent regulator. Additionally, MoT is working to develop vital legislation to divide the infrastructure and the operations of railways (MoT, 2014a).

The new railway project is planned to cover an 897 km/ standard gauge freight network. It aims to connect the capital Amman, major industrial cities and the logistics centers/ dry port (probable future project) and the port of Aqaba, the national gateway (see Figure 5).


Figure 5: New Railway Network in Jordan *Source (MoT, 2014a)*

Moreover, according to the planned railway project, the main line is the North-South line (Aqaba-Syria 509 km), which connects the main port and the Aqaba Container Terminal (ACT) with Amman and the industrial cities such as Zarqa; it extends as well to Syrian borders. From that line, the North-South line, a rail link extends to the phosphate mines at Alshaydiah (the largest mines). Another link is Zarqa-Iraq that links Jordan with the Iraqi borders (290 km). To complete the transport to neighboring countries, a link to Saudi Arabia is planned, which connects Jordan with Saudi Arabia (91 km) and Saudi Arabia with Syria and Europe (MoT, 2014a).

Regionally, the planned railway project aims at linking Jordan with neighboring countries, as it will create a bridge between the Gulf Corporation Council (GCC) and Europe It is

estimated that it will transport 29 million, 55 million tons of cargo in 2020 and 2040 respectively (MoT, 2014a) (see Figure 6).

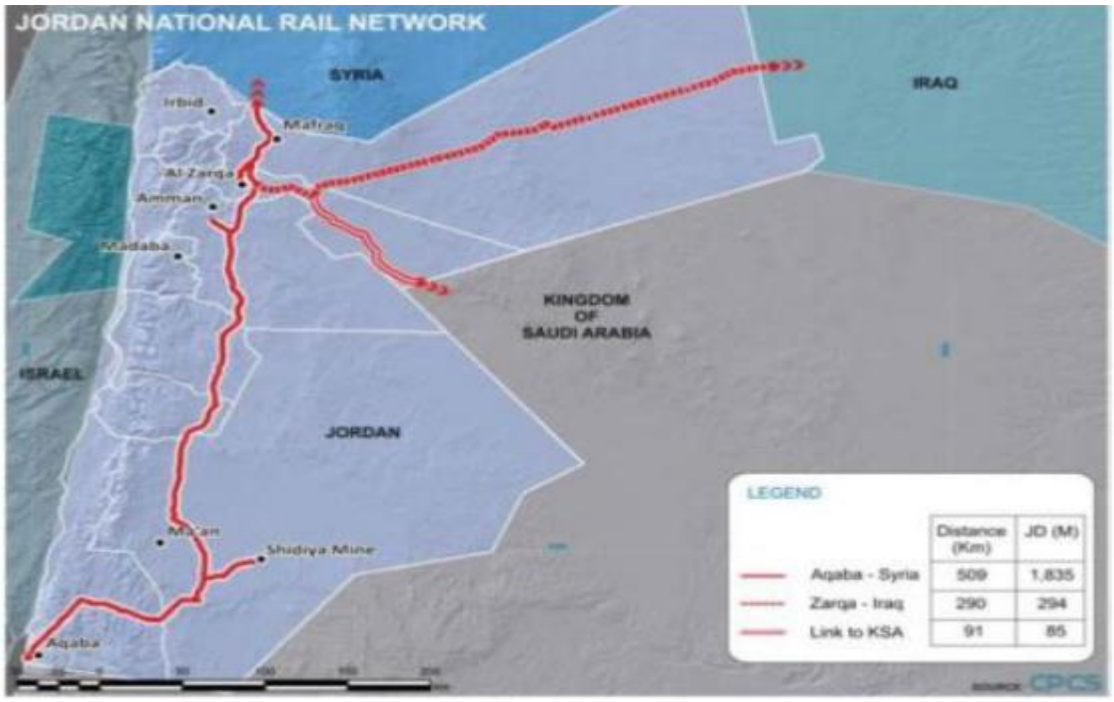


*Figure 6: The planned network to neighboring countries* *Source: (MoT, 2014a).*

The objective of the planned railways is to attract and serve customers in Jordan or regional countries such as Syria, Iraq, Saudi Arabia, and GCC states. It is expected that it will handle cargos of containers, oil products, grains and the main Jordanian export of phosphate and potassium. Moreover, Aqaba is considered the major gateway for Iraqi transit cargo with around 30% of Jordan's "transit cargo" heading to Iraq (ADC, 2017), so, the railway would carry a significant amount of cargo to Iraq. The foreseen regional network for the Arabic Peninsula is shown in Figure 7.

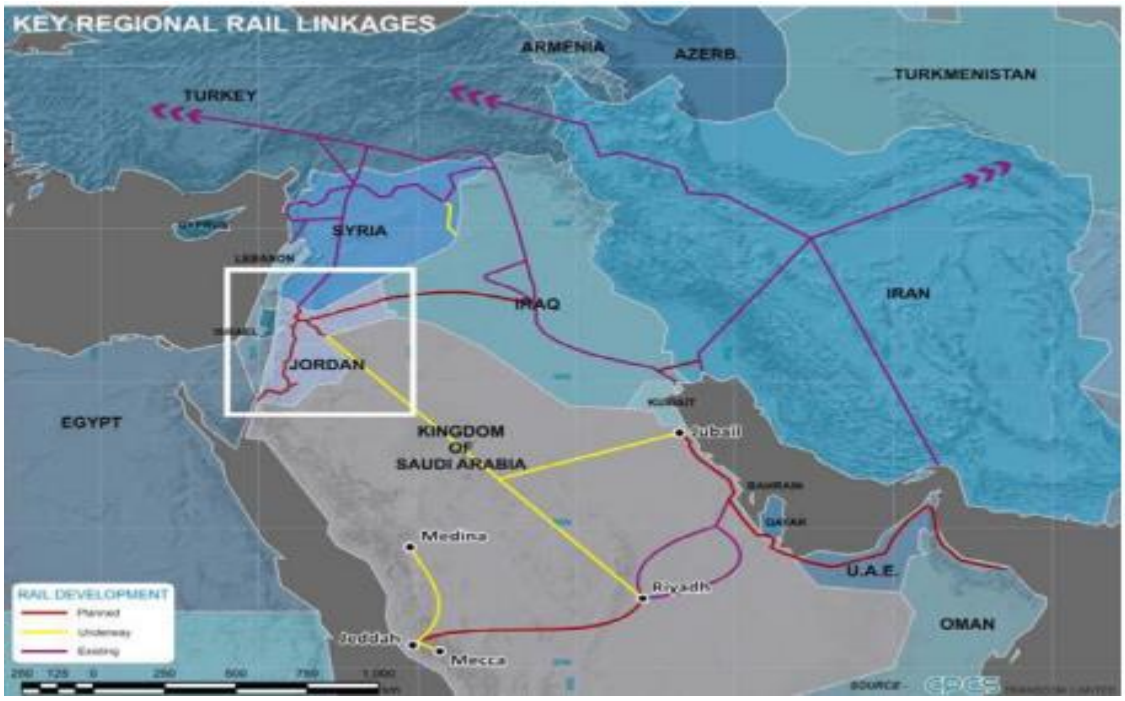


*Figure 7: Foreseen Railway Network for the Arab Peninsula* *Source: (MoT, 2014a)*

### 2.1.4. Air Transport Sector

As already mentioned, Jordan has three main airports. Although the amount of airfreight is still marginal, it does influence the logistics performance in Jordan. The main airport is Queen Alia International Airport which handles approximately 90% of international and domestic traffic and around 100,000 tons of cargo per annum. In 2013, 102,467 tons of freight were transported (JCARC, 2016). Further, Queen Alia Airport has various bonded warehouses. Regarding passengers traffic, around 7.1 million passengers fly yearly through Jordanian airports (JCARC, 2016).

#### 2.1.4.1. Air Transport Development

Jordan has privatized Queen Alia Airport to improve the ability of the air transport in Jordan. Moreover, the ADC is developing King Hussein Airport in Aqaba to be able to handle 800,000 passengers and a significant amount of freight, and in Mafraq, a military airport is being developed to conduct dual functions, military and commercial (JCARC, 2016). Overall, the airfreight sector does not t impact the dry port concept. However, it is still part of the whole logistics sector in Jordan, which is required to function satisfactorily.

### 2.1.5. Maritime Transport Sector

Ports are the main maritime transport sectors in Jordan; the sole port is Aqaba Port that is located south of Jordan at the northern tip of the Red Sea (see Figure 8). The ADC is the landlord of the port which is mandated by Aqaba Special Economic Zone Authority (ASEZA) to improve the operational performance, capacity, and efficiency of Aqaba Port terminals (ADC, 2015).

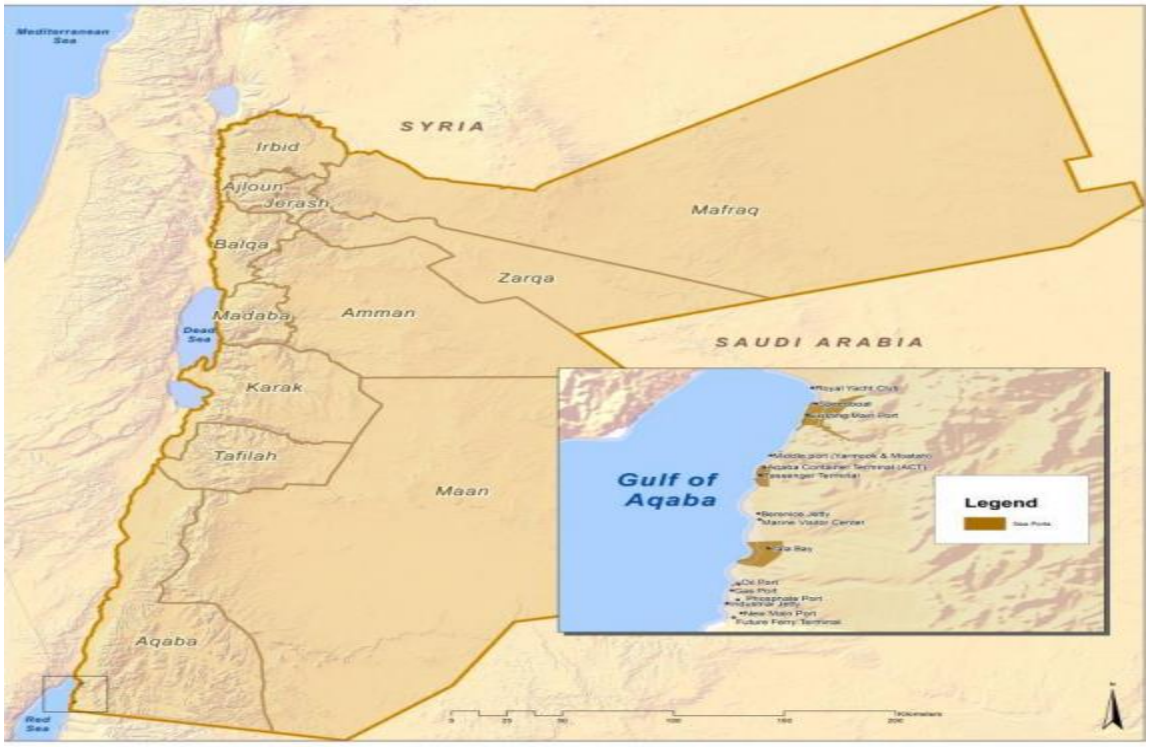


*Figure 8: Aqaba Port Map* *Source: (JIB, 2017)*

Aqaba Port, as shown in Figure 8, comprises 22 specialized berths that handle various goods, ranging from containers to general cargo, dry and liquid bulk such as phosphate, chemicals, crude oil and refined oil products. The port is distributed into three main areas, namely north where the main port is, middle (container terminal and RoRo) and south port (the industrial port) (ADC, 2015).

#### 2.1.5.1. The Aqaba Container Terminal (ACT)

The Aqaba Container Terminal has three gantry cranes (40-45 tons), two mobile harbor cranes, yard cranes, 376 reefer points, a container yard (500,000 $m^2$) and different container handling equipment. Table 2 has the terminal berth specifications. The current terminal capacity is 1.2 million TEUs, which reached 792,841 TEUs and 502 calling ships in 2016. Figure 9 shows ACT. ACT has the plan to execute an extension for the container terminal with an additional 460 meter long quay. The ATC at present accommodates containers ships up to 300+ meters long and up to 14.5 meters draft. All Jordanian ports including the ACT offer services 24/7 with three shifts.

*Table 2: ACT berths specification*

| **Berth-Number** | **Ships Displacement (Tons)** | **Ship's Length (Meter) max** | **Ship's Draft (Meter) max** | **Berth Length (Meter)** |
|---|---|---|---|---|
| No. 1 | 84,000 | 240 | 15 | 180 |
| No. 2 | 84,000 | 240 | 15 | 180 |
| No. 3 | 84,000 | 240 | 15 | 180 |

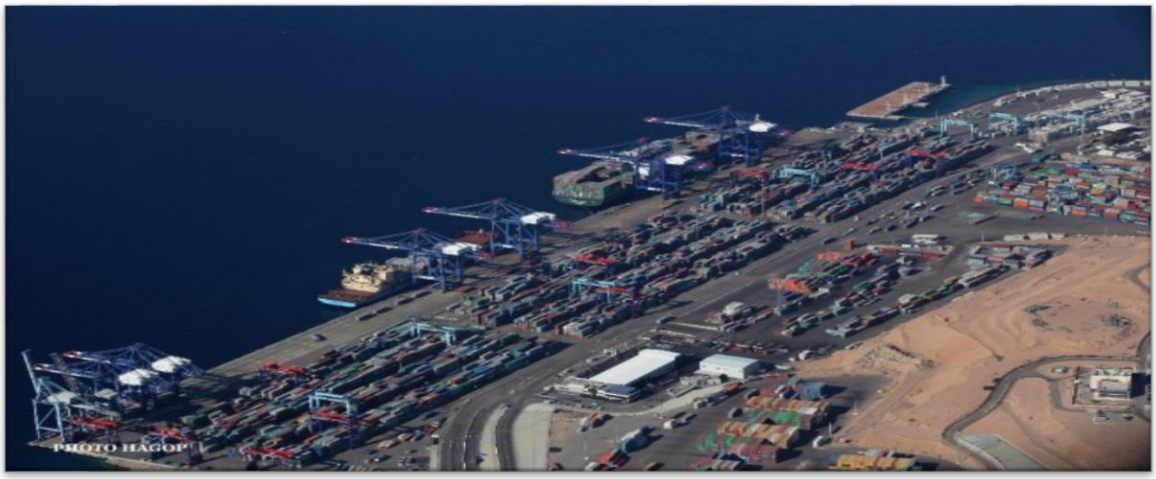


Figure 9: Aqaba Container Terminal berths *Source: (ADC, 2017)*

Importantly, the ADC always has very comprehensive master plans, which span up to 30 years, to develop and improve the port performance through terminal expansion. That is, to make sure the ports will meet all demands in advance, secure the country's cargo flow, meet the international standards and attract possible transit cargo (ADC, 2017).

The regional ports that serve the Jordanian market are two main ports in the Mediterranean Sea as part of the trade with the USA and the Euro Union. These ports are the port of Tartous in Syria (1.6 million tons in 2009) and Haifa Port in Israel with over 1.5 TEU recently. The port of Beirut may as well participate in serving the market; however, there are some disadvantages to carry freight from that port, such as long hauls on bad hinterland infrastructure and long crossing times via Syrian borders (ADC, 2015).

A major problem with container trade between Jordan and Syria is that no containers are allowed to enter or exit Syria, so stripping and stuffing are done at the borders before entry, at the Jordan-Syrian Free Zone for example. That adds up costs upon customers and compromise security.

#### 2.1.5.2. Jordan Containerization

According to the ADC study of containerization in Jordan (ADC, 2017), the containerization level in Jordan has witnessed fluctuation over the past 15 years. In 2005, it was 34.7% then in 2009; it increased to 87.84% due to a reduction in the import at Aqaba Port. Moreover, in 2014, it was 62% of the total import and export, excluding the liquid bulk cargo. The continuous rise in the containerization level in Jordan goes along with the global rise of containerization levels. Traders who ship their cargo by sea freight utilize containers, which is demonstrated in Table 3.

Table 3: World Containerization

| **Period** | **Total Containers Penetration** |
|---|---|
| 2000 | 5.7% |
| 2011 | 66% |
| 2014 | 90% |
| **Period** | **Containers market demand growth** |
| 2005-2010 | 5.5% |
| 2010-2015 | 3.1% |
| 2015-2018 | 4.4% (projected) |

*Source: (Statista, 2017)*

Looking at the above statistics that show that the container market, it is clear that general cargo shipped in containersis penetrating the whole market reaching a very high percentage

of penetration in 2014. With regard to the market demand growth of containers, containers grew 5.5% through 2005-2010 (including the shock caused by the economic crisis in 2009), then went down in the period of 2010-2015. However, it starts growing again in 2015 as it is projected to grow 4.4% in the period 2015-2018 (Statista, 2017). Generally, the container market is still growing even if it oscillates sometimes. Noteworthy to mention is that the deadweight of container ships was 11 million tons in 1980 and reached 228 million tons in 2015 (DP World Limited, 2017).

Hence, the global maritime container demand is growing (more deadweight, more penetration, and growing demand for containers), and Jordan is part of that growth too. It is sensible to think about meeting the current and future growth by providing more capacity other than the limited TEU capacity at ACT, 1.2 Million TEUs.

#### 2.1.5.3. Aqaba Port Container Volume (Throughput)

Table 4 demonstrates the container volume of ACT, subdivided into import, export, transit and transshipment

Table 4: ACT Containers Volume

| Year | TEU Traffic Total | Annual Growth | Total Import | Total Export | Transit | % of Total Import | Trans-shipment |
|---|---|---|---|---|---|---|---|
| **2005** | 392177 | ---------- | 198486 | 193691 | 35873 | 18.07% | 0.0 |
| **2006** | 405658 | 3.44% | 203868 | 201790 | 26307 | 12.90% | 1500 |
| **2007** | 414662 | 2.22% | 212175 | 202487 | 22286 | 10.50% | 24 |
| **2008** | 587530 | 41.69% | 298435 | 289095 | 48109 | 16.12% | 55079 |
| **2009** | 674525 | 14.81% | 335000 | 339525 | 80974 | 24.17% | 1983 |
| **2010** | 605659 | -10.2% | 302400 | 303259 | 53827 | 17.80% | 961 |
| **2011** | 705648 | 16.51% | 359078 | 346570 | 89367 | 24.89% | 51 |
| **2012** | 817434 | 15.84% | 410683 | 406751 | 93272 | 22.71% | 49 |
| **2013** | 872812 | 6.77% | 440031 | 432781 | 85203 | 19.36% | 212 |
| **2014** | 781291 | -10.4% | 394687 | 386604 | 46471 | 11.77% | 308 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **2015** | 758219 | -2.95% | 378212 | 380007 | 17634 | 4.66% | 26 |
| **2016** | 792,841 | 4.5% | 399299 | 393542 | 9002 | 2.25% | 230 |
| **Aver** | 650705 | 7% | 327696 | 323009 | 50694 | 15% | 5035 |

*Source: (ACT, 2017)*

The ACT capacity is 1.2 Million TEUs. The average annual growth 2005-2016 is 7%. However, the highest growth percentage appeared in 2007/2008 at 41.6%. The ACT capacity utilization reached its maximum in 2013 (72.7%), and the current capacity utilization in 2016 is 66%. Regarding the average daily traffic, it was 1,074 in 2005 and in 2016 is 2,172. In other words, the ACT demand is growing and the capacity utilization is increasing, leading to the fact that a dry port is required to accommodate the current and future growth.

With respect to the transit containers, which are destined or originating from other countries via the inland route, Iraq's share is the highest with a percentage of 70% of transit containers. Further, the Iraqi container share of the Jordanian import is estimated at 25-30% on average (MTBS, 2012). Importantly, transit cargo is considered potential traffic for the proposed dry port.

The transit containers fluctuated throughout the 2005-2016 period with an average of 15% per year, with the highest percentage growth of 115.87% in 2008 and the lowest -62.05% in 2015. The fluctuation is attributed to the crisis and instability in Iraq and Syria, mainly Iraq, as transit containers to Iraq are a function of the economic activities that are expressed by its GDP growth, which witnessed undergrowth over the recent period. The highest proportion of transit containers of total import was in 2011 at 24.89% and the lowest was in 2016 at 2.25%. Obliviously, it could be noted here that transit containers are still potential traffic for the dry port, yet, it is dependent on the resolution of the current Iraqi crisis, which is on the outset of being resolved.

The transshipment containers are a very small percentage out of the import; it fluctuated from 24 TEUs in 2007 to 55,079 in 2008, and the total average of it out of total import average is 0.13%, excluding 2008-2009 due to the shock happened that year. It can be

concluded here that the transshipment containers do not use the potential dry port; however, the rest of the containers (99.87% of total import) may be a potential traffic for the future dry port.

## 2.2. Logistics Market in Jordan

The logistics in Jordan is at the developing stage as it still falls low at the ranking of the world logistics performance index and with the agility report for the world emerging economies logistics.

Indeed, the need for special logistics centers in Jordan especially around seaports and in future dry ports lead to crucial logistics optimizations and improvement of Jordanian logistics and competitiveness in the region.

### 2.2.1. Jordan's Logistics Performance

Jordan's geography does not serve trade with European countries; its connectivity is low because there is no port on the Mediterranean. Therefore, using the port of Aqaba for this purpose adds substantial cost and time disadvantage. Nevertheless, Aqaba Port location, with the recent development in infrastructure and improving efficiency, is still vital to be an access to ports at the Red Sea for South and East Asia.

### 2.2.2. Logistics Performance Index (LPI)

Before discussing the LPI for Jordan, it is vital to understand the index itself and know the six components that make the index, which is as follows (World Bank, 2016):

- The efficiency of customs and border management clearance (customs)
- The quality of trade and transport infrastructure (infrastructure)
- The ease of arranging competitively priced shipments (International Shipment)
- The competence and quality of logistics services (Logistics quality & competence)
- The ability to track and trace consignments (Tracking & Tracing)

- The frequency with which shipments reach consignees within scheduled or expected delivery times (Timeliness)

According to the LPI that ranked countries regarding their logistics environment and capabilities, Jordan is still in the middle among the Middle Eastern countries; its rank is 67, and the score is 2.96. It is ranked higher than some of its neighboring countries as in the average LPI for years of for 2010, 2012, 2014, and 2016. Iraq was 158, Syria 166, Egypt 55. However, this not the case with some GCC countries as Saudi Arabia, which was ranked 47 or as Israel the west neighboring country, which was ranked 28. Still, Jordan is higher than the average of Middle Eastern and North Africa countries that get a score of 2.42.

The ranking and scores of Jordan as reflected in the LPI component with a comparison to a better logistical environment in a neighboring country i.e. Israel is shown in Table 5.

Table 5: Comparison between Jordanian LPI and Israel LPI

| LPI Components | Jordan | | Israel | |
|---|---|---|---|---|
| | Rank | Score | Rank | Score |
| LPI | 68 | 2.87 | 28 | 3.66 |
| Customs | 82 | 2.51 | 28 | 3.42 |
| Infrastructure | 68 | 2.68 | 27 | 3.57 |
| International shipments | 57 | 3.03 | 31 | 3.49 |
| Logistics quality & competence | 70 | 2.78 | 30 | 3.49 |
| Tracking and tracing | 75 | 2.78 | 27 | 3.68 |
| Timeliness | 67 | 3.32 | 17 | 4.14 |

Source: (World Bank, 2016)

As can be seen in Table5, Jordan is far away from its neighbor, Israel. Israel is ranked 28. The efficiency of customs and border management is the lowest in Jordan LPI, which is ranked 82. The logistics quality and competence of services, and tracking and tracing are very low compared to the other components. The international shipment cost is the best though. Timeliness is moderately good.

Other parameters and metrics of the domestic LPI (logistics, time and cost data) regarding the process of import and export in Jordan, are shown in Table 6 in comparison to Israel.

Table 6: Domestic LPI

| | **Jordan** | **Israel** |
|---|---|---|
| Number of agencies for import | 4 | 4 |
| Number of agencies for export | 3 | 5 |
| Number of forms for import | 4 | 3 |
| Number of forms for export | 4 | 2 |
| Percentage of shipment meeting the criteria | 83% | 95% |
| Clearance days without physical inspection | 2 | 0 |
| Clearance days with physical inspection | 3 | 1 |
| Percentage of physical inspection | 14% | 3% |
| Port or airport supply chain distance and (lead-time for export[1]) | 300 (5 days) | 300 (1 day) |
| Port or airport supply chain distance and (lead-time for import) | 300 (7 days) | 300 (2 days) |

Source: (World Bank, Connecting To Compete, 2016)

Obviously, Jordan still has problems with the import and export process. The number of agencies for import is four and for export three, and the number of forms for import and export is four compared to Israel, which is less, except for export agencies for Israel that are five compared to Jordan which is three.

The percentage of shipments meeting the criteria for Jordan is 83% and for Israel 95%. Another problem is the clearance for Jordanian goods. Clearance without physical inspection is two days, and with physical inspection it is three compared to Israel, which is zero and one day respectively. Moreover, the percentage of physical inspection is still high compared to better performing countries, ie 14% in Jordan and three percent is for Israel, which is indeed a big difference that leads to much more cargo dwell times.

The port and airport supply chain distance and lead-time for export are 300 km within five days, and for import 300 km within seven days, which t is very high lead time compared to one to two days in Israel.

1 From the point of origin (the seller's factory, typically located either in the capital city or the largest commercial center) to the port of loading or equivalent (port/airport), and excluding international shipping (EXW to FOB).

It seems that Jordan has issues with customs procedures, such as official clearance procedures, and logistics services that increase import and export lead times and other underlying complications.

### 2.2.3. Agility Emerging Markets Logistics Index

According to the (Transport Intelligence, 2015), the Jordanian economy has suffered as it was badly strained by the flow of refugees from Syria and the instability of Iraq, Jordan's largest trading partner, due to the presence of ISIS. In addition, the energy crisis has hampered growth in the country. However, the index stated that Jordan has a high market potential with few barriers to market entry.

The metrics that gauge the countries in this index are three, market size and growth attractiveness (50% of the Index score), market compatibility (25% of the index score), and the market connectedness (25% of the index score).

Jordan, which gets reasonably high scores (among 45 emerging markets) for its business climate (market compatibility), dropped five spots to number 29 in the 2015 Index, with a score of 4.54 in 2015 compared to 4.81 in 2014. For its sub-indices, Jordan gained a high score for market compatibility (6.51), and for the market connectedness (5.28). On the other hand, it gained a lower score for the market size and growth (3.06). The market compatibility sub-index goes up due to the openness towards FDI in its infrastructure projects and programs to improve transport sectors and to encourage domestic consumption (Transport Intelligence, 2015). Furthermore, the sea freight is fast growing in Jordan, as the above report explained (EU/US to Emerging Market), Jordan index grew 13.6% from 2011 to 2014.

Importantly, Jordan needs to consider to develop and streamline their logistics performance, as well as avoiding and sorting out problems in order to be a frontrunner and improve their trade.

On the whole, it could be concluded here that Jordan is moderately developing and would be considered at the lead of Middle Eastern countries in terms of logistics performance. Nevertheless, it still has quite a few problems that need to be squared away, which will

lead to developing and streamlining the logistics performance. These problems will be discussed thoroughly in the next chapter.

## 2.3. Customs Centers and Bonded Areas

The export and import of goods legally require the inspection of those goods. Customs physically check out goods to see if they are identical to the documents provided and to calculate customs rates if required. Certainly, the custom is considered a fundamental part of the logistics chain, which has to be efficient in order to facilitate the flow of goods.

With Amman customs house having the biggest share of container clearance (70%), it is located in the city of Amman at a small area, which creates

traffic jams in the capital. The following are the customs centers in Jordan (Jordanian Customs, 2017) (see Table 7):

Table 7: Customs Centers in Jordan

| | Customs Center | | Customs Center |
|---|---|---|---|
| 1 | AL-Ramtha Customs Office | 11 | Prince Mohamed Bridge Customs Office |
| 2 | Al- Mahatah Bonded Customs Office | 12 | Amman Civil Airport Customs Office |
| 3 | Aqaba Customs Laboratory | 13 | King Abdullah 11 Industrial Estate |
| 4 | Amman Customs Laboratory | 14 | Al Shidiah Customs Office |
| 5 | Airport Customs Office /Clearance | 15 | Omari Customs Office |
| 6 | King Hussein Bridge Customs Office | 16 | Amman Post Customs Office |
| 7 | El- Hassan Industrial Estate Customs Office | 17 | Special Bonded |
| 8 | Jordan Valley Crossing Point Customs Office | 18 | Al- Hussein Bin Abdullah II Estate Customs Office |
| 9 | Amman Customs Office | 19 | Zarqa Free Zone Customs Office |
| 10 | Al- Mudawara Customs Office | 20 | AL-Karamah Customs Office |

Resource: (Jordanian Customs, 2017)

Moreover, the bonded areas, which offers warehouses solutions and logistics services, are as in the following Table 8:

*Table 8: Bonded Areas in Jordan*

| | Bonded Area | Space | Location |
|---|---|---|---|
| 1 | RITCO bonded area | 65.000 sq.m. | between Amman city and Sahab |
| 2 | GTC bonded area | 120,000 sq.m. | At Amman/ Yadoudah |
| 3 | AMPCO bonded area | 36.000 sq.m. | At Amman north of the Airport |

| | | | |
|---|---|---|---|
| 4 | Queen Alia International Airport (several logistics companies have Bonded warehouse facilities, used for air and land freight) | Very wide spaces | At Amman |

Resource: (Jordanian Customs, 2017)

Based on Table 7 and Table 8 that showed the customs centers and bonded areas in Jordan, it is clear that Jordan has enough customs centers but few bonded areas. Custom centers are spread all around the country, at borders, development zones, and the capital city Amman. Establishing a dry port that is in a very suitable location close to customers and markets, and has all the logistics, customs, bonded areas and storages, and other required services, would save time, costs, and cut down traffic in the cities.

## 2.4. Jordan's Industrial, Manufacturing, and Free Zones

Jordan established Qualified Industrial Zones (QIZ)[2], manufacturing and logistics, to facilitate the international trade, which is either as Special Economic Zones (SEZ) or as Development Zones (DZ). The QIZ include logistics services and warehousing, provided or future planned. Jordan then created the Development Zone Commission (DZC) to manage and supervise the DZs and SEZs (Jordan Investment Board, 2016).

In addition to the above mentioned DZs and SEZs, Jordan established free Zones (FZ). FZ that may overlap with SEZ such as in Aqaba, as both exempt companies and employees from all Jordanian taxes with license and permit fees. Table 9 shows the investments Zones in Jordan.

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2 The Development and Free Zones Law enables and empowers the private sector to lead in the development and management, delegates full power to the Development and Free Zones Commission to create an efficient one stop shop that provides streamlined quality of service and governance, defines a clear land ownership policy, removes all restrictions on foreign capital and offers a comprehensive customs and tax incentives coupled with transparent implementation practices (MTBS, 2012).

Free Zone: means a specified and walled part in the Jordanian lands, which is allocated for the purposes of storage of goods and conducting Economic Activities. Such lands are considered to be out of the customs' burdens and restrictions, as the entrance of the goods to such area and performance of the Economic Activities are considered to be entered and conducted outside Jordan.
Development Zone as any area under the Jordanian customs sovereignty that is announced to be as a Development Zone in accordance with the terms of the Development and Free Zones Law (MTBS, 2012)..

Table 9: Investment Zones

| Name | Type | Ownership | Size (1000 $m^2$) | City |
|---|---|---|---|---|
| King Hussein Business Park | DZ | Public | 365 | Amman |
| Ma'an Development Area | DZ | Public | 750 | Ma'an |
| Irbid Development Area | DZ | Public | 3.200 | Irbid |
| KHBT Development Area | DZ | Public | 21.000 | Mafraq |
| Dead Sea Development Zone | DZ | Public | 2.200 | Ajloun |
| Dead Sea Development Zone | DZ | Public | 40.000 | Balqa |
| Sahab Free Zone*[3] | FZ | Public | 63 | Amman |
| Queen Alia International Airport | FZ | Public | 120 | Amman |
| Abdullah II ibn Al Hussein Industrial Estate* | QIZ | Public | 2.530 | Amman |
| Al Hassan Industrial Estate* | QIZ | Public | 1.178 | Irbid |
| Al-Hussein bin Abdullah II Industrial Estate* | QIZ | Public | 1.885 | Karak |
| Al-Mowaqar Industrial Estate * | QIZ | Public | 2.500 | Amman |
| Aqaba Industrial Estate* | QIZ | Public | 2.750 | Aqaba |
| Al-Zarqa Industrial Estate * | QIZ | Public | 2.475 | Zarqa |
| Al-Tafilah Industrial Estate * | QIZ | Public | 1.000 | Tafila |
| Madaba Industrial Estate | QIZ | Public | 500 | Madaba |
| Al Tajamouat Industrial City | QIZ | Private | 420 | Amman |
| Ad-Dulayl Industrial Park | QIZ | Private | 345 | Zarqa |
| Mushatta International Complex | QIZ | Private | 4.400 | Amman |
| Hallabat Industrial Park | QIZ | Private | 500 | Zarqa |
| Cybercity | QIZ | Private | 4.000 | Irbid |
| El-Zai Ready-wear Manufacturing | QIZ | Private | | Zarqa |
| Gateway QIZ | QIZ | Private | 50 | Irbid |
| Al-Qastal QIZ | QIZ | Private | 4.000 | Amman |
| Hashemiya University | QIZ | Private | 1500 | Zarqa |

Source: (Jordan Investment Board, 2016)

The importance of DZ, FZ, and QIZ is for the dry port establishment. Legally, foreign investment is allowed in such zones. Furthermore, investors are granted privileges, facilitations, and tax-free goods. Most of DZ have a wide scale of land that belongs to the government with roads and services that keep them vibrant. It is recommended that the dry port to be established in one of those zones.

## 2.5. Summary

This chapter explained Jordanian ports, transport, and logistics, including important nodes and links for the logistics chain as the customs houses, border crossings, development and

[3] Logistics services are offered including warehousing and manufacturing

free zones and bonded warehouses. Further, the current status of Jordan's logistics performance was compared to a neighboring country. Although Jordan provides a wide variety of services and infrastructure, there must be some problems that hold back the advancement of Jordanian logistics. Thus, this will be explained in the next chapter including solutions to patch up the problems.

## Chapter Three: Logistics and Transport Sector Problems and Solutions

The transport and logistics sectors are vital sectors for the Jordanian economy and an important component of daily life, as well as an essential requirement to provide mobility and access. Thus, they maintain current economic activity, which is also a base for the future economic growth of the Kingdom and a way to improve the quality of citizens' lives.

Jordan needs to develop its logistics and transport sectors to ride the track of global supply chains and to meet the current and future challenges. Due to the increasing development in infrastructure and networks in neighboring countries that increase their competitiveness and market share e.g. Israel and Saudi Arabia, they score higher than Jordan in the LPI and Agility reports, Jordan needs to exert efforts to catch up with those countries so it does not lose its competitiveness in the market.

Moreover, Jordan is a part of the LOGISMED initiative with the purpose of connecting Middle Eastern countries and North African countries with Europe by sea or by the extension of their hinterland (European Investment Bank, 2012). Therefore, improving and developing Jordanian logistics and transport sectors are deemed necessary and important.

The following are issues and problems encountered in the logistics and transport sectors in Jordan with recommended solutions. Some issues are not merely logistics or transport; however, they could be considered as a consequence of the problems within logistical and transport sectors in Jordan. The problems are divided into three main sources: institutional and governmental regulation problems, operation problems, and information problems[4].

[4] The information used in this section is based on wide variety of resources, such as the Agility report, Logistics Performance Index, Jordanian Customs, Ministry of Transport, country's report on transport and logistics, short interviews with some stakeholders " over the phone" as clearance, shipping and transport agencies.

### 3.1. Institutional and Governmental Regulation Problems

The institutional structure of the Jordanian transport sector is very complex, where each transport pattern is operated and managed throughout a number of institutions and bodies. In a more precise sense, there are different institutions for most modes of transport that are responsible for (MoT, 2014a):

- Infrastructure planning, infrastructure development, maintenance and operation
- Regulatory functions of the sector
- Operation of vehicles, service providers

At the national strategic level, different ministries are responsible for certain sectors or modes of transport or part of the infrastructure, which are as follows:

- The Ministry of Transport is responsible for the development of public policies in the field of inland transport, civil aviation and maritime transport
- The Ministry of Public Works and Housing responsible for road transport, but not responsible for the operation of public transport and the transport of goods

Other ministries that are involved in the process include:

- The Ministry of Planning and International Cooperation
- Ministry of Energy
- Ministry of Commerce and Industry
- Ministry of Interior Affairs

In addition, different regulatory bodies "commissions" are responsible for implementing strategies and policies and for operating transport systems:

- The Land Transport Regulatory Authority is responsible for the regulation and licensing of public transport, transport of goods on roads, and railway transportation
- The Civil Aviation Regulatory Authority is responsible for the implementation of policies prepared by the Ministry of Transport and the organization of civil aviation including commercial air transport policy

- The Jordanian Maritime Authority is responsible for organizing, developing and supervising the maritime transport sector and improving the role of private sector, competition promotion, environmental protection and maritime safety standards
- The Aqaba Special Economic Zone Authority is responsible for developing the region "Aqaba" in order to attract investments and provide a sophisticated investment environment.

The first issue to be analyzed is the interaction and coordination between the ministerial level and the organizational or executive level. The Ministry of Transport is responsible for providing financial resources and distributing these resources in coordination with the authorities concerned, while the regulatory authorities and private authorities, which have been mentioned previously, are responsible for the implementation of these strategies and plans.

With regard to roads, they are considered public utilities, and the Ministry of Public Works and Housing is concerned with the development and maintenance of road networks. It undertakes to build and maintain them. It is clear in Jordan that the road sector has a very prominent role. Road transport is by far the most important mode of transport. The Ministry of Transport is focusing on other means such as aviation, maritime transport, railways and public transportation, but it remains responsible for designing a public policy for the transport sector, including the development of the infrastructure of roads.

This results in common responsibilities at the highest levels of government for the most important parts of the transport sector. These bodies are responsible for organizing and operating their own patterns, or in their area, as in the case of ASEZA. The responsibilities are not always clearly defined as there are overlaps of responsibilities at both the ministerial and organizational levels. Some institutions have the same institutional structure, with similar divisions and functions, so these departments deal with similar issues (ministerial or organizational level). Seemingly, there is no clear coordination between the Ministry and the regulatory authorities. This leads to repetition of work and loss of efforts and, in some cases, to contradictory outputs i.e. contradictory laws and regulations.

### 3.1.1. Solutions for Institutional and Governmental Regulation Problems

The complex institutional structure and situation with the responsibilities allocated to the most important transport pattern (inland transport) require closer inter-ministerial cooperation and coordination, and greater exchange and sharing of data and information than the status now with full and formal responsibilities.

Importantly, sector management and institutional reforms are deemed necessary for regulatory and operational issues and licensing. One of the challenges facing the transport sector in Jordan at present is the complex institutional structure within the transport itself and the resulting problems with cross-responsibilities, funding, organization and operation of the transport sectors, and vehicle licensing and services. Therefore, the national transport strategy has assessed the sector and identified ways to improve it, such as (MoT, 2014b):

- Improving communication and cooperation at the ministerial level (Ministry of Transport, Ministry of Public Works and Housing, Ministry of Planning and International Cooperation, Ministry of Commerce and Industry)
- Improving coordination between different levels of transport sectors
- Defining clear responsibilities for planning, organizing, financing and operating transport systems in different modes of transport
- Establishing procedures for coordination and organization at the institutional level

Indeed, there is a need for greater coordination in the field of legislation across all relevant transport institutions (including the Ministry of Transport, the Greater Amman strategic Municipality, the Public Transport Regulatory Authority, the Aqaba Special Economic Zone Authority, the Jordanian Maritime Authority, the Civil Aviation Regulatory Authority and the Aqaba Railway Corporation). This includes the integration of established plans.

## 3.2. Operational problems

### 3.2.1. Infrastructure Problems

Currently, Jordan's national transport infrastructure consists of a network of 7,130 kilometers of roads, including around 3,400 kilometers classified as main roads, 2,050 km are secondary roads, and 2,270 km are village roads. Although most highways and main and secondary roads are classified as reasonably good and provide the capacity to meet demand mostly in terms of traffic flow, the Amman / Zarqa urban network constitutes a major obstacle to local and regional traffic, especially in terms of regional connection and cargo shipments. Most main roads passing through Amman such as Highway 15, 35 and 40, have problems in terms of traffic density and roads size (sizes start from 20 meters to thirty with two lanes) (see Figure 10).

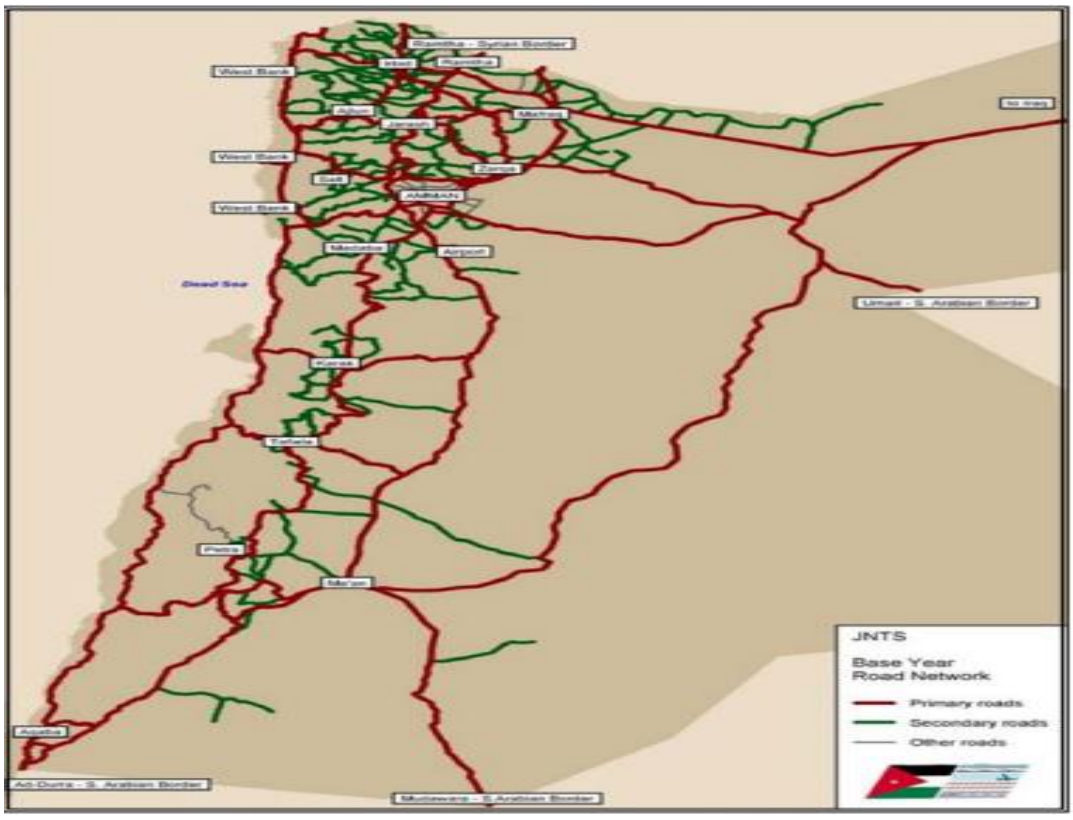


Figure 10: primary (highways) and secondary roads Source: (MoT, 2014a)

As for freight transport, Jordan's internal transport relies heavily on road transport, as the alternatives are virtually non-existent. Jordan has a narrow-gauge historical railway,

originally part of the Hijaz railway (built by the Ottoman Empire at the beginning of the twentieth century). The southern part of the line was extended with modern links to the port of Aqaba from the phosphate mines in the south of Jordan. Except for this limited link through the railway, there is no other transport system for the carriage of goods locally other than the use of roads, which has a negative impact on the economic, social and natural environment in Jordan.

Therefore, it is worth mentioning that some action must be taken in different areas (e.g. maintenance, widening and upgrading of road infrastructure); otherwise, it is expected that the current situation of the existing infrastructure may get worse and deteriorate in the future. Obviously, trucks and heavy cargo vehicles, in particular, are putting additional pressure on the roads, resulting in serious deterioration in some roads, such as holes and cracks. This situation will be exacerbated with the increase in the transportation of goods over time. Consequently, it is necessary to have intensive maintenance programs to maintain continuity of road transport.

### 3.2.2. Customs Issues

#### 3.2.2.1. Border Crossing

There are many problems at the border crossing. Importantly, most of the facilities (buildings) and IT systems are old and not able to accommodate the rising trade volumes at the borders. The basic facilities such as weighbridges, parking yards, shelters and scanning machines are not available in most border crossings. That brings about congestion and long queues, which hinders the flow of goods. Trucks may wait for more than six to ten hours or even more until they are cleared (MoT, 2014b). That hampers Jordan's efforts to be a logistics hub for neighboring countries and other continents.

#### 3.2.2.2. Customs Facility at ACT

The custom facility at the ACT is not sufficient to clear all the inbound containers. The ACT container inspection yard capacity is 180 TEU, whereas the demand is 400 TEUs; however, this issue was solved by linking ACT with an outside custom yard, (see custom yard four as a case at the end of this chapter). In addition, if a container is going to be

cleared in Amman, a fee still needs to be paid to Aqaba customs, which amounts to 50 JD. This fee is extra and it is not justifiable because no clearance procedures are conducted in Aqaba.

#### 3.2.2.3. The Customs Houses

The custom houses, such as Amman customs house is quite congested and it is located very close to the city, which results in congestions in traffic and noise. Nonetheless, there are plans to widen the current location or build a new customs house near Amman in a place called Al Madounah.

#### 3.2.2.4. Clearance Time

The clearance time is long, that is, the clearance days without physical inspection is two days and with physical inspection is three days. In addition, the percentage of physical inspection[5] is 14%, which is still high compared to neighboring countries such as Israel (3%). The customs yard capacity at the container terminal is 180 TEUs; however, there is always a demand of 400 TEUs. Theses clearance issues add up burdens in the total time for import and export and increase the cargo "containers" dwell time.

Moreover, the container dwell times depends on the speed of the clearance and the cooperation of the shipper or consignee; the dwell time is still high as it was fourteen days (at the ports or bonded warehouses) and currently it is around 10 days after the establishment of customs yard four outside the ACT (see the custom yard four as a case in this chapter).

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[5] The customs categorized imported containers into three groups, red, green, and yellow. The red group is composed of 60% of imported containers and it is always inspected at the ACT custom yard (Customs, 2017).

### 3.2.2.5. Solutions for the Customs Issues

The time required to transport goods through border crossings can be reduced by improving infrastructure, equipment, procedures and working conditions including the following:

- Provide adequate facilities equipped with equipment to increase the efficiency of operation. There is an urgent need to accelerate the establishment of comprehensive border crossing facilities (with Saudi Arabia, Iraq and Syria) and the creation of a single-window system, with facilities for goods and passengers, assembly areas, parking areas, warehouses, shelters, cargo inspection centers/ ramps, weighbridges, workshops and other facilities that are necessary for efficient customs work
- Simplification and facilitation of border crossing procedures and documentation process, which should be subject to performance standards. Therefore, the border crossings must contain modern and sophisticated facilities i.e. stationary and mobile scanners to reduce the time it takes to clear exports and transport goods
- Use of electronic information in the control, and for examination and information sharing
- Use of a trained and motivated staff. It is also necessary to train existing administrations to maintain existing qualified and efficient leadership.

A strategy should be designed to take major actions, such as eliminating physical determinants by investing in transport and trade infrastructure (roads, railways, border crossings and inland facilities. The determinants are as follows:

- Removing institutional determinants by enabling trade-related institutions
- Removing policy-related determinants by harmonizing transport and trade policies, tariff policies, and encouraging participation in bilateral and multilateral transport agreements
- Promoting greater involvement of the private sector for investing in cross-border transport and freight transport

Importantly, there is a need for a comprehensive IT-based database to be updated by the Ministry of Transport, including all key performance indicators in order to keep track of the irregularities in border operations and provide any required improvement.

If Jordan implements an integrated and comprehensive strategy, it could gain significant reduced travel time, rapid growth in border trade, job creation, operational cost savings in the truck and other transport modes, reduced travel costs and shipping, total cost reduction, revenue returns and business income.

### 3.2.3. Import and Export shipments Issues (Long Lead-Time)

Despite the fact that export lead-time (300 km in 5 days) is less than that of the import (300 km in 7 days), both are still high. That indeed undermines the countries supply chain competitiveness and integration with international markets. The lead-time is long owing to the red tape processes for acquiring clearances, filling out many forms (Customs, Clearing agency, shipping agency, and trucking company) and dealing with plenty of agencies. There are three agencies for export (Customs, Department of Standards and Criteria, Department of food and Medicine) and four agencies for import (Customs, Department of Standards and Criteria, Department of food and Medicine, Department of Agriculture). However, the number of agencies may increase as well depending on the type of goods that are imported. For example, the Ministry of Environment may interfere in the shipment.

### 3.2.4. Low Logistical Competence

The information technology is not highly utilized in the logistics sector; in addition, there is no single window system for import and export at the border to organize the flow of goods, and there is no sole authority that yet controls all border crossings.

The previously addressed operational and institutional problems in Jordanian transport and logistics explain the low ranking of Jordan in the Logistics Performance Index 2016, as it was the $68^{th}$ country. In addition, the agility emerging markets logistics index, 2015, ranked Jordan at 29. The agility report was gained from its low sub-indices, which are: the country market connectedness, market compatibility and size of growth.

Furthermore, in Jordan, there are many warehouses (different locations, see chapter two), either bonded or none bonded, which are scattered all around the country. The issue here is that most of them were developed to serve Amman (the capital) and Aqaba city (the seaport city). This increases the time of clearances for other markets and of course increases congestions.

Moreover, there is a demand for the third party logistics providers (3PL) to provide logistics services (inventory management, warehousing, and distribution, freight forward, cross docking) or large 4PL providers that have logistics, transport and supply chain solutions (manage firm's supply chains ) to mega firms. The number of 3PL is limited, as there are not more than 10 and three 4PL. These providers help in providing a solution in transportation, JIT, and maintain good records of data using very developed systems. In addition, this let the firms focus on their core operations rather than being disrupted by arranging logistics and transportation, which eventually will decrease the total cost of transport.

### 3.2.5. Comprehensive Solution for Logistics and Transport Sectors Problems, and Export and Import Issues

The development of transport infrastructure (transport of freight and passengers) can be achieved by expanding the scope of foreign ownership and liberalizing the industry. Jordan needs to take further steps to develop solutions to its logistical problems, which undoubtedly affect trade and competitiveness of all its exports of goods and services.

The construction of a commercial logistics system by policy makers in Jordan requires the adoption of proactive policies aimed at improving export competitiveness and improving the quality of infrastructure as a component of the wealth of future generations in the long term. The Ministry of Transport should consider a comprehensive reform program based on a short-term strategy aimed at developing an efficient transport sector and creating an environment conducive to business performance. These strategies may contain establishing of a dry port that has logistics, customs, and transport solutions.

#### 3.2.5.1. Establishing a Dry Port

It is a very significant way to relocate ports activities away from the port utilizing cheaper and environmental friendly multimodal transportation. It can alleviate the congestion at ports and transfer all the clearance and custom related processes to that location, which is a simple way of providing decongestion to the port and extension of the port hinterland. It can as well provide logistics and value added services benefiting customers in many aspects. Shippers or consignees as customers will have easy shipment utilizing the dry port facilities and various supportive functions. The dry port, however, needs to be efficiently connected to all economic centers with easy access that saves time and costs utilizing the most recent technologies.

### 3.3. Information problems

Jordan has been actively involved in the implementation of the Single Window System[6], which aims to increase the efficiency of the Customs. A single window is there to simplify and speed up border operations and the automated development of customs data. The main purpose behind the implementation of the single window system is to reduce the number of signatures and documents necessary for import and export or transit goods. The general customs service is very optimistic about the creation of this system (Jordanian Customs, 2017). However, the system is not yet complete, and it is not available for border crossing. The same issue is with the port services and trucking companies as the single window is not applied, and there are many documents, forms, and institutional work that complicate the trading process, (see operational problems for agencies and forms for imports and exports in this chapter).

#### 3.3.1. Solutions for Information problems

The information system in the logistics and transport sectors is still not highly developed and needs to be improved by applying the following solutions:

1- *Computerized system for predicting transport* "evaluation and prioritization methodology". The joint use of the computerized transport forecasting system along with

[6] SWS cuts the red tape, which is highly required to sort out problems at import and export. It simplifies documentation and accelerates the flow of information between the traders and governmental agencies. The documents, payments and other related steps can be lodged through the system in uniform and homogeneous steps electronically.

the prioritization process to provide quantitative inputs to support the decision-making process, allowing for the selection of the final strategy (MoT, 2014b)

The computerized system is a tool designed to represent the current conditions of the transport system within Jordan (internal flow) and between Jordan and other countries (regional level) and forecasting future conditions without any application of the strategy procedures (baseline scenario) and applying different alternative strategies to assess their impact.

2- Develop and integrate maritime and land transport services through use and utilization of *Electronic Data Interchange (EDI)* to facilitate the trade and information sharing among agencies, traders, and governmental departments. One of the great benefits of the EDI is exchanging documents electronically, which improves transaction speed and visibility while decreasing the amount of money customers spend on the regular manual processes.

3- Linking of the port information system and the VTS by *International standards-based IT systems* that merge truck companies, cargo terminals, railway stations and administrative authorities, shipping and clearing agencies, RO-RO cargo operations, shipping lines and customs terminals, all together to facilitate all transport and logistics procedures.

4- Jordan needs to take steps to address the logistical problems that affect the competitiveness of the transport sector without a doubt, in addition to the sectors that depend on it. There is a need for a *comprehensive information database*, supervised by the Ministry of Transport, so that the legislative institutions provide the Ministry with the key performance indicators (KPIs) on a monthly and annual basis. All these KPIs are announced in terms of performance, operation, costs, accessibility, movement, efficiency and returns on the same basis, monthly and annual. This would improve the performance of all institutions and allow for amendments and modifications.

### 3.4. Customs Yard Four as Case Study

The custom yard was an initiative by Aqaba Especial Economic Zone Authority (ASEZA), the regulator; it is owned by the Aqaba Development Corporation (ADC) and managed by Aqaba Port Management Company (APMC). The yard has become a new customs center that moved the customs clearance process from Aqaba Container Terminal (ACT) to it.

According to a statement by ADC (ADC, 2017), the clearance time for imported containers decreased from five days to two days, and the total dwell time decreased from fifteen days to nine days.

In this regard, the ADC has published a report indorsing the benefits gained since the establishment of the yard, (ADC, 2017), which could be concluded as follows:

- The average time for waiting and clearance process "dwell time" has decreased from 15 days to 9 days. Still, ADC aspires to reach to the global best practices in this respect by bringing the dwell time to 3 days
- Cost of handling goods decreased by around JOD 14 million since the start of the yard. This indeed has a positive impact on cost of imported goods and to the containers supply chain
- The interplay of handling, clearance, and storage requirement at the ACT was removed: thus, that increased the ACT capacity for storage handling and maneuvering of containers
- Aside from the steps taken to ease the clearance process and the activation of simultaneous inspection, the quantity and quality of inspections, and quality of goods imported increased and the smuggling and criminal acts were abolished.
- Full container increased by 5.5%, from 377,995 TEUs (2015) to 398,914 TEUs (2016), and its dwell time improved by 43%, as it went down from 12.7 days to 7.2 days. In general, the throughput volume at ADC increased 4.6 %
- The Yard has generated around JOD 5 million profit, with 270 and 150 direct and indirect jobs created respectively.

Aqaba customs conducted a study (Jordanian Customs, 2017) that stated it takes five days to gather shipping documents e.g. bill of lading and delivery order. These documents are needed before customs start its clearance procedures because procedures start once the customs declaration and these documents are submitted. Therefore, decreasing dwell time is dependent on the cooperation and coordination level between customs with traders, forwarders, clearing agents, and shipping agents. Therefore, using a pre-clearance application by all stakeholders, launched by ADC, was promoted to solve the above mentioned problems.

### 3.4.1. Yard Layout

The yard has three primary lanes, as shown in Table 10, with a total capacity of 315 trucks. However, there are 44 ramps for customs inspection inside the yard. The ramps have a productivity average of 220 to 250 containers. The ADC intends to increase these ramps up to 68 at the end of the year 2017 in order to increase the capacity and decrease the total dwell time. Thus, productivity will rise up to 400 containers per day.

Table 10: Yard 4 Capacity

| Lanes name | No. lanes | Trucks | Total capacity |
|---|---|---|---|
| Main Gate Pass | 10 | 18 | 180 |
| The middle lanes | 7 | 13 | 91 |
| Lanes preview ramps | 44 | 1 | 44 |
| Total | | | 315 trucks |

Resource: (ADC, 2017)

### 3.4.2. Case Discussion

Looking at the benefits that were gained from moving the customs clearance from the ACT to the customs yard, it seems that wide benefits were gained from this project. Containers dwell time has decreased from fifteen days to nine days, and the clearance time decreased from five days to two days. In addition, the revenues reached 14 million and most importantly, the ACT throughput has increased too.

It could be argued here that such a project yields many benefits and improves the countries' container supply chain; however, the question is whether such a project could be improved

and regulated to a bigger project as a dry port that contains logistics and value added services in a location that is close to all markets in Jordan. Surely, this will facilitate the shipping processes and reduce the total cost of trade. Such concept will be further discussed in the next chapter.

## 3.5. Summary

This chapter explained the problems and issues that lie within the Jordanian transport and logistics. The issues are very frequent and different and, therefore, need solutions and studies. Then, various solutions to alleviate and eradicate the problems were discussed. These solutions vary from big scale and expensive to normal and less capital investments. In addition, the solutions discussed the issue within the regulatory, institutional and ministerial department in Jordan, which is considered important to sort out without the need for investment. Lastly, a case was explained, Customs Yard Four, as an example of reformations and solutions to customs clearance problems within Aqaba Container Terminal (ACT). The next chapter studies the dry port as a suitable solution that helps in downsizing the problems within the logistics and transport sector. Importantly, the study will conduct a specific center of gravity model to find the best location in Jordan.

## Chapter Four: Dry Port as Possible Solution with Assessment of the Best Location

### 4.1. Dry Port as a Solution

According to the World Bank (2016), research conducted by the World Bank and the United Nations Economic and Social Commission for Asia and the Pacific on trade costs stated that the connectivity of maritime transport and air transport network, along with logistics performance are the main determinants of the country's trade cost. Apparently, Jordan's trade cost is still high, and that cost is moved to the last consumer eventually. That undeniably deteriorates the country's competitiveness and push away traders or investors as the benefits are not high or very limited.

There are numerous problems that were discussed earlier, *inter alia*, the high dwell time of containers and goods in Aqaba Port. Many agencies are involved in declaration and trade, customs complications, declaration and clearance obstacles, transport problems, and fees issues. Obviously, a dry port would help avoid these problems and decrease container dwell time.

Roso and Lumdsen (2009) augmented this explained solution "Dry Port" by stating that the transport chain could be stimulated by moving the storage further inland, close to the final customers and clients. Moreover, the storage time of containers would not only be reduced, but also, be subjected to a better administration, and that would decrease the total cost.

According to (Roso & Lumsden, 2009) in their research, the dry port concept, moving seaport activities inland, they claimed that: "Implementation of a dry port into a seaport transport system, that is the seaport's hinterland, should create a seamless transport chain, smooth transport flow with one interface in the form of dry port concept instead of two interfaces, one at the seaport and the other one at inland destination". In other words, two

nodes in the transport chain, seaport and inland terminal, should be replaced with one “dry port concept” node”. Nonetheless, considerable time and financial savings are gained by diminishing the congestion “queues” at the gates of seaports and by moving the storage of container inland; therefore, it allows customers to exchange their cargo at geographically closer and more easily accessible hubs.

Calling back the solutions offered in the previous chapter, the dry port seems to be one of the best solutions that needs to be further discussed and analyzed. A dry port building in Jordan captures many of the solutions that were foreshadowed earlier as it improves the country’s international trade and competitiveness. It can have positive impacts on many aspects, which could be summarized as in the following:

1. It eases and alleviates congestion at Aqaba Port and the container terminal; thus, increasing port productivity;
2. The dry port solution would help abolish some trade problems in logistics services (warehousing, distribution, packaging, unpackaging), transport and value added services. For example, it expands the customs inspection for the container terminal to a wider and organized location;
3. It decreases the transport and logistics costs, and time of shipments, such as providing cheaper storages of goods and cheaper transport. Therefore, traders can plan their production sensibly as the dry port is close by;
4. Swifter and faster efficient customs clearance, which results in timesaving;
5. Improving the port and borders connectivity with market centers;
6. It solves the issue of the fee that is deducted at container terminals for clearance at inland customs offices, which improves profit gains;
7. The ability to include and use technologies, such as the single window system
8. It promotes and attracts Foreign Direct Investments (FDI) for the transport sector, as investors are keen to participate in profitable projects and gain privileges from the Jordanian government;
9. It helps ports to focus on its core duties, ie maximize, and diversify its maritime potential. Moreover, it extends the ports hinterlands and improves ports productivity by allowing the port to handle more cargo;

10. It can be used as distribution center for close markets;
11. It is attractive as it is considered one stop shop, e.g. it has logistics services, warehousing, storages, forwarders and banking, insurance ;
12. It provides jobs opportunities that help decrease the growing unemployment in Jordan;
13. It reduces the risk of accidents and maintenance costs for highways due to the use of multimodal transportation from the seaport to the dry port.
14. It reduces risk congestion at the seaport cities.

It could be argued that Jordan lacks the multimodal networks, such as railways network that link the seaports with the dry port. However, as explained in the status and future development of the transport sector in Jordan, there are envisaged plans for connecting Jordan nationally and regionally by railway networks. Assuming that the railway network and the trucking services will be running along with the dry port operation, the study seems to be feasible to some extent. Nonetheless, further assessment is very necessary to provide proof and justifications of such investment.

### 4.2. Assessment of Dry Port best location (A Center of Gravity Model Solution)

A suitable and convenient dry port should be situated close to large markets with large consumers' area. In other words, to save and decrease the cost of transport and logistics in the overall transport chain. The location of the dry port is required to have high connectivity with other markets and have a potential of new markets, importantly, be a potential for the transit cargo too. Moreover, it needs to be located where the envisaged railway network is planned and in a very close location to local and regional highways.

To run the gravity model in the spread sheet the required data of all Jordanian markets are needed (Governates/Municipalities). In Jordan, there are twelve markets as shown in Table 11 and Figure 10. Table 11 also shows the name of the markets and their population.

Table 11: Jordan Markets 2016

| | Name | Population |
|---|---|---|
| 1 | Ajloun | 176,080 |
| 2 | Aqaba | 188,160 |
| 3 | Balqā | 491,709 |
| 4 | Kerak | 316,629 |
| 5 | Mafraq | 549,948 |
| 6 | Ammān | 4,007,526 |
| 7 | Tafiela | 96,291 |
| 8 | Zarqā | 1,364,878 |
| 9 | Irbid | 1,770,158 |
| 10 | Jarash | 237,059 |
| 11 | Ma'ān | 144,082 |
| 12 | Ma'dabā | 189,192 |

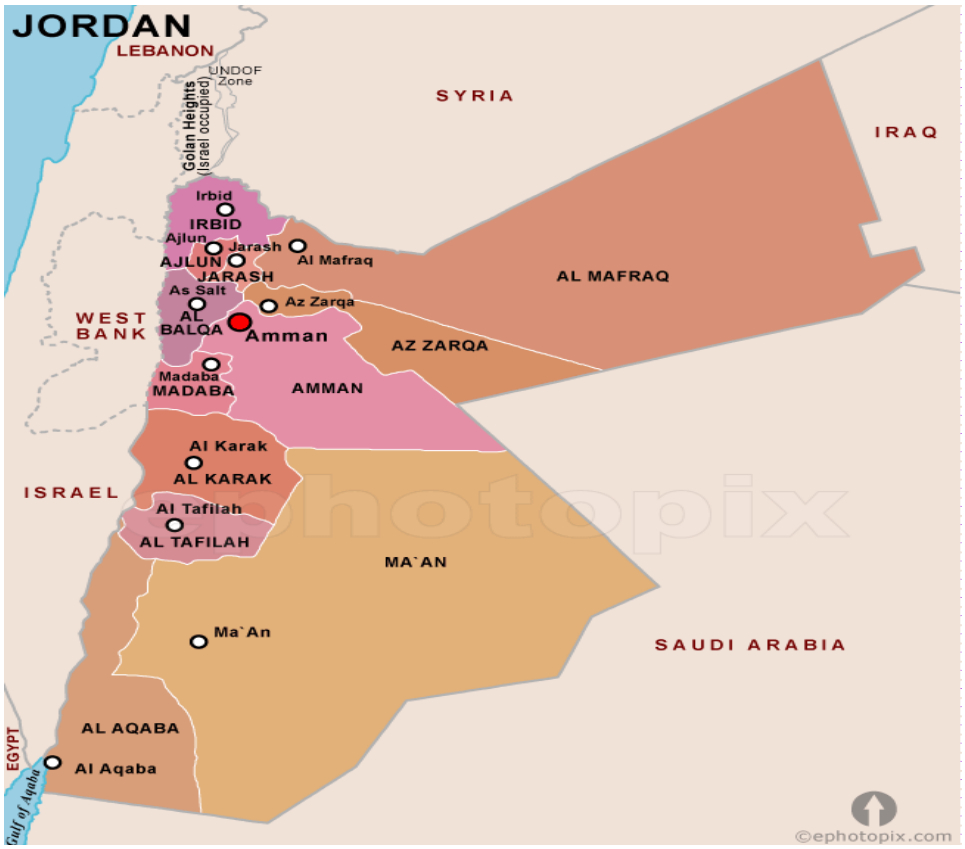


Figure 11: Jordan Map with Governorates (main markets) *Source: (Ephotopix, 2017)*

Moreover, the cost of transporting a 20 TEU container from Aqaba to Amman is about 450 dinars ($633 USD). It is distributed between 255 dinars for the fuel, which represents 55%

of the transfer, 40 dinars as driver gratuity, 35 dinars for the driver's fare, 10 dinars for changing the oil, 10 dinars for food, one hundred dinars for the trucking company (MoT, 2014a). That makes the truck transport cost is around $2 USD per TEU per km after considering the base price for any truck movement to any location.

The above map "1:55 km" (Figure 10) was laid on a grid, then the coordinates were extracted as per the following Table 12. Moreover, market demands of TEUs in import and export are included in the same table.

Table 12: Market Coordinates and Their Demand

| | Coordinates | | Transport cost ($F_n$) | Quantity in TEU ($D_n$) | Percentage out of Jordan Market |
|---|---|---|---|---|---|
| | $x_n$ | $y_n$ | | | |
| Aqaba | 8 | 20 | 2 | 15651 | 2.0% |
| Ma'an | 82 | 87 | 2 | 11985 | 1.5% |
| Tafilah | 70 | 154 | 2 | 8009 | 1.0% |
| Karak | 77 | 190 | 2 | 26337 | 3.3% |
| Madaba | 85 | 244 | 2 | 15737 | 2.0% |
| Amman | 102 | 268 | 2 | 333343 | 42% |
| Balqa | 80 | 278 | 2 | 40900 | 5.2% |
| Zarqa | 116 | 280 | 2 | 113530 | 14.3% |
| Jarash | 100 | 303 | 2 | 19718 | 2.5% |
| Mafraq | 130 | 310 | 2 | 45744 | 5.8% |
| Ajloun | 90 | 310 | 2 | 14646 | 1.8% |
| Irbid | 95 | 333 | 2 | 147240 | 18.6% |

Solving the center of gravity location for the thirteen markets using Microsoft Excel 2016, thirteen different iterations were acquired. As can be seen in table 13**,** there was no further improvement after the fourth iteration.

Table 13: Calculation Iterations

| **Iterations** | **(0) Initial** | **(1) First** | **(2) Second** | **(3) Third** | **(4) Fourth** | **(5) Fifth** | **(6) Sixth** | **(7) Seventh** | **(8) Eighth** |
|---|---|---|---|---|---|---|---|---|---|
| $X'$ = | 0 | 80 | 99 | 102 | 102 | 102 | 102 | 102 | 102 |
| $Y'$ = | 0 | 218 | 260 | 269 | 268 | 268 | 268 | 268 | 268 |
| | **(9) Ninth** | **(10) Tenth** | **(11) Eleventh** | **(12) Twelfth** | **(13) Thirteenth** | | | | |
| $X'$ = | 102 | 102 | 102 | 102 | 102 | | | | |
| $Y'$ = | 268 | 268 | 268 | 268 | 268 | | | | |

Table 13 and Figure 11 show that there is no improvement beyond the fourth iteration after the coordinates (X, Y) (102, 268), which means that the location (102, 268) is the best location of the dry port that has the lowest transport cost (see Appendix A for the detailed quantitative method of the iteration of the center of gravity model). The result gravity calculation was Amman market (the capital city), so it is very clear that Amman is a big market, with a demand of 333,343 TEU of import and export.

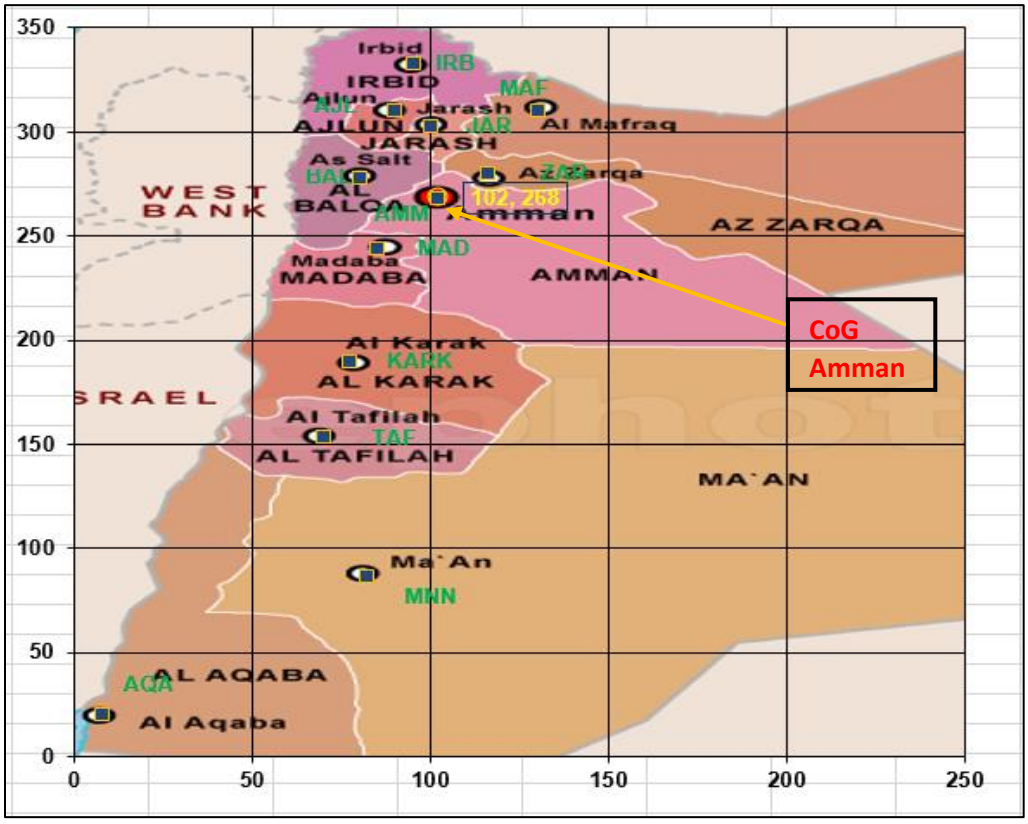


Figure 12: Center of Gravity Model Map

### 4.3. Transport Costs, distance and Time Saving Analysis of the Dry port

The cost, distance and time saving analysis will compare the transport costs saved, time and distance, by having a dry port in the recommended location "Amman" to all the proposed locations by the Jordanian government. It is noteworthy to mention that Jordan has suggested and studied building a dry port in three locations, Amman, Aqaba, and Mafraq, more recently. ADC started to work on a study to build a dry port in another location, which is in Ma'an. The appropriate location has not yet been approved by the

government because the concept is still in the feasibility study phase. Therefore, this analysis shows the benefit of having a dry port in Amman as per the result of the gravity model, which certainly would yield time, distance and costs saving. Table 14 shows the comparison of distance, time and cost saved by Amman dry port versus all other proposed locations.

Table 14: Transport Cost, Distance and Time Saving Comparison

| City | **Dry Port Distance in Km** | | | | **Distance Saved or Lost** | | |
|---|---|---|---|---|---|---|---|
| | **From Amman** | **From Aqaba** | **From Mafraq** | **From Maa'n** | **Amman Vs Aqaba** | **Amman Vs Mafraq** | **Amman Vs Ma'an** |
| Irbid | 104 | 440 | 46 | 320 | -336 | 58 | -216 |
| Ajloun | 90 | 416 | 66 | 225 | -326 | 24 | -135 |
| Jerash | 70 | 396 | 56 | 268 | -326 | 14 | -198 |
| Mafraq | 71 | 400 | 0 | 284 | -329 | 71 | -213 |
| Balqa | 50 | 376 | 100 | 247 | -326 | -50 | -197 |
| Amman | 0 | 326 | 76 | 230 | -326 | -76 | -230 |
| Zarqa | 35 | 361 | 55 | 250 | -326 | -20 | -215 |
| Madaba | 36 | 300 | 105 | 213 | -264 | -69 | -177 |
| Karak | 125 | 285 | 180 | 170 | -160 | -55 | -45 |
| Tafilah | 178 | 201 | 250 | 103 | -23 | -72 | 75 |
| Ma'an | 211 | 120 | 285 | 0 | 91 | -74 | 211 |
| Aqaba | 326 | 0 | 400 | 120 | 326 | -74 | 206 |
| Average Distance | 108 | 302 | 135 | 203 | -194 | -27 | -94.5 |
| Average Time (hours) | 2.6 | 7 | 3 | 5 | -4.4 | -0.4 | -2.4 |
| Average Cost($2 per Km) | 216 | 604 | 270 | 405 | -387.5 | -54 | -189 |

Table 14 shows that the average distance from Amman dry port to all markets is 108 km, which is the lowest among the other proposed dry ports (Aqaba, Mafraq, and Ma'an). In addition, the average distance that is saved by having the dry port in Amman compared to Aqaba is 194 km, whereas in Mafraq it is 27 km and in Ma'an (which is the highest) it is

94.5 km. Further, the average time for Amman dry port to Jordan markets is 2.6 hours which is the lowest among the other three locations, and time saved by using Amman dry port compared to Aqaba is 4.4 hours, compared to Mafraq with 0.4 hours, and to Ma'an with 2.4 hours.

Lastly, the average cost for using Amman dry port by Jordanian markets is $216, whereas for Aqaba, Mafraq and Ma'an the cost is $604, $270, and $405 respectively. In other words, using Amman dry port on average is the lowest cost. With regard to cost saved by using Amman dry port compared to Aqaba, it is $388, to Mafraq is $54, and to Ma'an is $189. Obviously, building a dry port in Amman has the benefit of saving distance, time and cost for all Jordanian markets.

### 4.4. Dry port impact on transport Cost

The establishment of the dry port in Amman as the previous calculation showed, may result in the beginning of a cost increase on customers due to the additional handling in the dry port, especially for containers that come from Aqaba and are destined for non-bonded warehouses. In fact, the transport saving in the beginning of the operation of the project yield benefits for the ACT because of the terminal capacity increase (more earning) and the decrease of container dwell time. Nevertheless, the dry port will definitely decrease the logistics cost; consequently, that makes the dry port a suitable alternative as it offers quicker custom clearance that saves time. Further, the storages cost would be less because of the fewer ground prices and the economy of scale, not forgetting to mention the availability of a wide variety of services that are attractive for the dry port customers.

### 4.5. Discussion

According to ADC2017, the expected cost of constructing a dry port will exceed 300 million USD, which is a very large investment. Therefore, the profitability of this project should be commensurate with the size of the investment. However, according to ADC 2017, this project is considered a good economic feasibility but setting it up in an inappropriate location or setting up more than one, will result in reduced the profits and the benefits from the desired project.

The idea of having more than one dry port in one country, especially the countries where the market is relatively small, such as Jordan, is considered to be an economically useless idea and will have a negative impact on the productivity and the cost. It is unreasonable to construct more than one dry port to attract containers that do not exceed Million TEUs annually

In addition, it is not feasible to set up a dry port to receive less than 10% of the total containers exported and import through Jordanian port. If we assume that it will be established in Ma'an or Aqaba, it will serve the markets surrounding it that are Karak, Tafilah, Ma'an and Aqaba markets which are 7.8% of the Jordanian market. In contrast to the location of Amman, where it will serve the surrounding markets which in the north, central and east of Jordan in addition, it will serve the transit TEUs to or from Iraq, Syria, Israel and Saudi Arabia and this constitute a (92.2%) of the market.

From here we conclude that it is not conciliatory to establish more than a dry port in Jordan. Moreover, instead of establishing another dry port, the feasibility study for other projects should be conducted, which help to increase the productivity and efficiency of the Jordanian ports and solve some of the transport and logistics problems which mentioned previously.

Given the empirical justification, this research proposes that the dry port be built in Amman for many reasons aside from the augmentation by the gravity model result.

1. Amman dry port will attract more than 90% of exported and import containers. As explained in the previous paragraph.

2. The main Jordanian highways and regional highways (Saudi Arabia as an alternative highway, Iraq, Syria and West Bank) cross the city, which make the dry port connected with all governorates of the Kingdom with a good transport network and serve the transit goods importantly to Iraq.

3. The future planned railway network locally and regionally passes by Amman, which makes Amman’s dry location compatible with the railway plan.

4. Amman has industrial cities and as well three important Development Zones (King Hussein Business Park, Sahab Free Zone, Abdullah II ibn Al Hussein Industrial Estate) that can contain the dry port within due to the fact that this DZ has wide free lands and entertain wide variety of privileges that would attract local and foreign investors and reduce the capital cost of the project.

5. There is no doubt that the various services provided in the capital of some countries are the best compared with other governorates as in the case of Jordan. So, these services will have a positive impact on the operation of the dry port.

6. The presence of international airport close to the dry port opens the door to facilitate the intermodal transportation between both of them. Of course that increase the volume of handling and as well attract more customers due to the fact that the customers will have multiple options to ship their cargoes either by air or by ships down to the port of Aqaba. Thus, customers (shippers) would be able to compromise cost and time factors.

7. According to Jordan Chamber of Commerce (JOCC), 2017 Amman market is the largest market in Jordan as well as the most active and growing market compared to other Jordanian markets, which will influence the dry port performance increase the productivity and the efficiency of it in the future.

8. The shippers can get the BL or the customs clearance as soon as they deliver the cargo at the dry port, this saves time because they do not have to wait until it reaches Aqaba port and loaded onboard the ship. Hence, they are able to get their money from the bank as soon as possible.

9. The construction and tourism sectors are more active in Amman than other governorates.

10. It will be easy to monitor and develop the project as it will be close to the decision-makers in Jordan.

11. Storage the goods and owning warehouses are considered a high cost for some traders, so they seek to store their goods in warehouses companies and then withdraw their needs on a daily, weekly or monthly basis, which reduces the total cost for them.

The dependence on the center of gravity to determine the best location and the presence of the dry port near to the high-weight market encourages these traders to rely on the warehouse's companies which supposed to be close to the dry port, so it will be easy and not costly to deliver these goods. Moreover, this will encourage the public and the private companies to invest in the surrounding area, especially in storage and distribution sectors.

Returning to case study in the third chapter, and according to ADC 2017, customs yard 4 is considered one of the most successful projects for several reasons such as; it increased the productivity and efficiency of the Aqaba container terminal, the revenue in the first year was almost 5 million JD, the dwell time decreased from 15 days to 9 days and it offered more than 350 job opportunity. This yard can be considered similar to the dry port in some aspects. Therefore, the dry port in Amman will obtain more positive results than that which yields from the customs yard 4. Moreover, this yard can also be used to attract containers exported or import from or to the nearby markets which are Karak, Aqaba, Tafileh, and Ma'an and the rest market can use the potential dry port in Amman.

However, there are some disadvantages of setting it up in Amman such as it is known that the growth, development, and investment are often the highest in the capitals of some countries as in the case of Amman. So, establish the dry port there will increase the development and provide jobs in Amman, which against to the Jordanian government view, which is to allocate the gains and national projects in various governorates to develop these governorates and create job opportunities in all regions. Moreover, Amman is considered the highest density of population and very crowded city compared with other governorates, so the establishment of the dry port there will increase the load on basic services such as water, electricity, etc. and will complicate the crowded problem. Furthermore, the price of land and real estate in Amman is considered the highest compared to the rest of the governorates so setting it up there will increase the prices too, so it will weaken the private investment opportunities in the area surrounding the dry port because of the high prices of the land, real estate, and the high salary scale which will add up more cost on them and reduce the revenue from any project. Finally, having a dry port may add some other cost which related to cargo handling.

Moreover, the application of the center of gravity model has some disadvantages. For example, it uses the relative distance so that may not give the right location as it take the distance between the governorates as a straight line and the difference among all distance are not the same. Furthermore, it does not take into account the governorates terrain that is dissimilar in Jordan as some of these governorates have mountain topography and others have flat topography. Also, the status and topography of the roads, which connect these governorates, are not considered; those roads are different in construction and nature, some might be longer in distance than a straight line. In addition, it just considers the cost and time saving according to the amount of cargo carried, however, some other aspects in the different locations are not taken into account such as; the prices of the land, real estate, salary scale, and congestion etc. which may impact the feasibility and the success of any project. Moreover, the transportation cost for some governorates might increase due to the imbalance of trade; some trucks come back empty after delivering the containers because some governorates are consumers only (no productions) or vis a versa. So, that fact is not factored in the model and may impact the model if it were quantified. Also the cost of transport might be unrealistic for some governorates because the more the distance crossed, the less the cost incurred. But, in the model all costs are flat rate after the base charge and other fees of transport were factored in.

### 4.6. Reasoning

Based on the proposition recommended for a dry port in Jordan, and analysis carried out in this chapter, it seems that the dry port is feasible. The dry port would certainly have shared from the cargo entering and leaving Jordan (transit). However, the dry port itself will not be able to square away all the problems related logistics and transport, but it can provide a better condition for logistics and the transport of goods. It will move a huge workload from the ports to the dry port with many benefits that have been explained earlier.

The dry port concept develops the need for reformation and development required to streamline logistics and transport. This ultimately leads to optimization and it improves the country competitiveness in the Middle Eastern region.

According to the Gravity model that was applied and the cost, distance, and time saving calculation, it seems that a dry port in Amman is the best location that would offer a wide variety of benefits to shippers and consignees, apart from the other benefits to the port itself.

## 4.7. Dry Port Design and Functionality

The concept of the dry port has a multi facet function; for example, it includes a container handing terminal, a storage yard, customs inspection and clearance, bonded warehouses and storages and a container freight station for stripping. Generally, dry ports attract logistics activities to be nearby or included within the dry port itself "integrated into one project", as a logistics center, such as value added services, warehouses, and private storages.

Based on the previous analysis of Jordanian logistics and transport and the recommendation to build a dry port in Amman as a solution for many problems therein, the dry port needs to have the genuine functions and the design of latest dry port design and functions. According to research conducted regarding dry ports Hanaoka and Regmi, 2011; UNCTAD, 1991; UNESCAP, 2015; Kühn, Warsewa, Tholen and Seidel, 2011; Roso and Lumsden, 2010, Amman dry port needs to have the following design and functions.

### 4.7.1. Dry Port Function

#### 1. Custom Function

Generally, the imported goods arrive at the Jordanian seaport of Aqaba where they are cleared inside the port after completing the port formalities e.g. dues, duties, and taxes, and then the goods are transported either directly to the client or stored in a non-bonded warehouse around Jordan. Another option is that imported goods, if not cleared in Aqaba, are transported to a customs house in an inland depot, free zones or industrial zones under the Jordanian customs regime, frequently, to the Amman region. As mentioned earlier, there are problems within Jordanian logistics, even if containers are transported to be cleared in Amman, a fee is still required to be paid for customs in Aqaba, which amounts

to 50 JOD. This fee needs to be removed and all fees needs to be deducted in the dry port only.

Moreover, the goods that are transported to be cleared in another area in Jordan are mainly containers (they are customs sealed). With regard to the general cargo or transit cargo, it is under the customs discretion to decide and move the goods in convoys if possible or keep the clearance in Aqaba only, especially if transport is not safe or secured. Obviously, the customs presence is important for traders to clear their goods. The dry port needs to have customs-owned storages, non-bonded warehouse, inspection area, and offices. This is very vital to improve the development of the dry port and to attract more cargo in the future.

**2. Logistics Center**

The logistics center is a very important requirement within the dry port because it offers logistics solutions for the shippers and consignees. This requires the availability of offices for the logistics companies that could offer private storages and non-bonded warehouses, transportation and distribution.

**3. Information Technology Service**

The IT is very important to facilitate the trade because it offers container tracking and tracing. In addition, if a single window is incorporated, linking all stakeholders as customs, shipping lines, banks and ports, it would make the dry port very competitive.

### 4.7.2. Dry Port Facilities (Design)

The following illustration in Figure 13 shows the proposed facilities and design of the conceptual dry port.

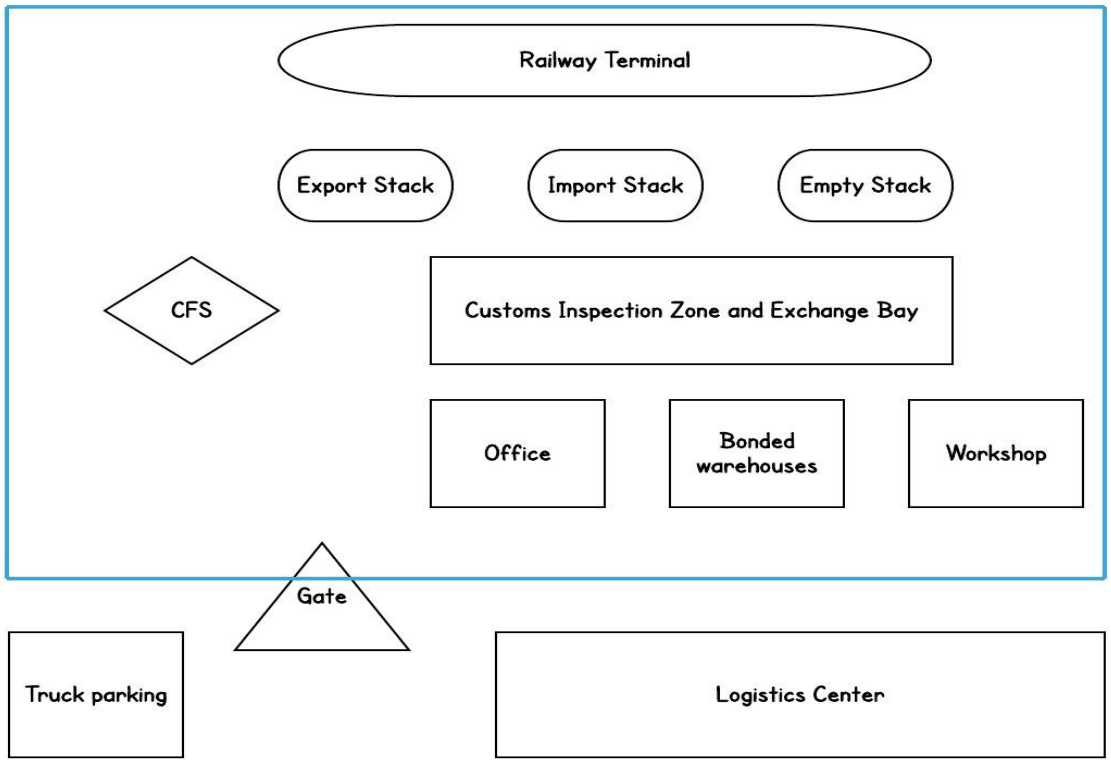


Figure 13: Dry Port Layout

**1. Railway Terminal**

The railway is very important as it is considered one of the pillars that make the dry port concept successful utilizing the economy of scale and offering a seamless goods transport. Therefore, a railway terminal with loading and unloading equipment, dedicated for trains such as rail mounted crane is deemed necessary.

**2. Full Container Yard**

The full container yard is the area where full containers are stacked; it has two main areas. First, there is the import container stack to stack the full containers that are received from ACT. With respect to LCL, they are stacked there to be transferred to the CFS for stripping, then the empties are moved to the empty container yard. From the full container stack, FCL after clearance, are loaded on trucks on the way to customers. Usually, the full import containers are stacked behind the export containers. Secondly, the export container stack,

full or empty that is received from shippers, is stacked for export. Normally, the export containers are stacked next to the railway terminal.

**4. Empty Container Yard**

This yard is dedicated for empty containers, which is called most often as empties. These empties are either containers that come from CFS after being stripped or from the importers or shipping lines.

**5. Customs Inspection Area and Payment Facility**

This area is an open area where containers or goods are stacked for customs examination and inspection. The payment facility, however, is to expedite and regulate the payment of fees etc.

**6. Exchange Bay**

The exchange bay is the area where trucks offload containers to be moved to the stacks or for ready cleared containers to be loaded on trucks heading to clients.

**7. Container Freight Station**

This is the area where LCL are stripped and emptied for importers or empty containers are stuffed for export. However, FCL could be stripped here sometimes. The CFS offers consolidation of goods, stripping, unstrapping and packing.

**8. Bonded Warehouses**

These warehouses are under the customs regime, especially for storing non-containerized cargo. Usually, these warehouses are run by private operators.

**9. Cold Storage Yard and Facility**

The cold storage yard is important for reefer containers, regarding the cold storage facility, it is used to store goods that are perishables.

**10. Offices**

For administrative purposes, there have to be buildings that have offices for different entities at the dry port e.g. customs, dry port operator, and authority, and for commercial services in addition to logistics service providers, freight forwarders, banking and insurance services

### 11. Repair Workshop

This workshop is used for containers and trucks repair and equipment maintenance.

### 12. Gates

The gates are important for the counting and regulating throughput entering and leaving the dry port. Within the gate, the weighbridge is required to weigh container and truck loads.

### 13. Trucks Marshalling Yard

Trucks wait at the marshalling yard to get permission to enter the dry port either for loading containers or goods at the exchange bay or loading containers or goods for clients.

### 14. Equipment

For the ease of handling of goods and containers, efficient and modern equipment is needed within the port. This contains a rubber tired gantry crane (RTG) for stacking import and export containers at the full container yard, a rail mounted gantry crane (RMG) for loading and offloading containers from trains at the train terminal. To reach stackers for the exchange bay, tractor trailers for movement between the exchange bay and the stacking area, CFS and warehouses, forklifts are needed for loading and offloading of cargo.

## 4.8. Summary

This chapter discussed the dry port as a solution that would capture various problems in the Jordanian logistics and transport sector. A gravity model was applied to propose the best location of the dry port and to make sure that the transport cost, time and distance saving would stimulate the appetite of the traders and attract them. Moreover, a comparison

with the other Jordanian government proposed locations was conducted which supported the gravity model result that Amman dry port is a very suitable and competitive location.

Finally, yet importantly, the design and functionality of the dry port were built up as a recommendation to the Jordanian government. The next chapter is the conclusion chapter where a summary of the study will be briefed wrapping up the whole research.

## Chapter Five: Conclusion

### 5.1. Summary

The research, assessment of the best location of a dry port in Jordan, was aimed at finding the best location for a dry port in Jordan bearing in mind previous studies that tackled the feasibility of having a dry port in Jordan. However, those studies were not focusing on the proper location that would be close to the markets and decrease the total cost of transport. The research, however, explored the transport and logistics sectors in Jordan and went through the underlying problems, then consolidated the dry port concept that would capture many solutions of the problems. The research aim and objectives were thoroughly discussed and elaborated throughout the chapters of the study.

The research achieved the four objectives that were the main core of the dissertation, the following are the objective:

1- To discuss the reasons why a dry port is required in Jordan.

In order to dig deep into the other related aspect to build a dry port in Jordan, it was needed to find out why the dry port is important to Jordan. This objective was achieved in chapter two by studying the status of Jordanian transport and logistics sectors and then going through the problems that hinder the progress of the sectors that undermine Jordan's competitiveness and increase the total cost of transport and logistics.

It seems that there are many projects that aim at developing both sectors; however, they are still many problems within both sectors. These problems were divided into institutional and governmental problems, operational problems, i.e. infrastructure, customs and truck transport issues, and information problem, e.g. the unavailability of national single window that contain all the department that are in charge of transport and import and export and data base that could be used as a benchmark and a platform for the KPIs and any future improvement trials.

2- To address applicable solutions for problems in logistics and transport sectors in Jordan and in import and export via Aqaba Seaport.

The research, after the exploitation of all the problems, presented solutions in chapter three directly after every main problem discussed. The solutions were various such as regulatory and institutional reformation that would bring the entire ministerial and other governmental departments together in one channel to reshape the responsibility on the transport and logistics. Moreover, with regard to the operation problem, some easy solutions that targeted the road infrastructure, customs, border crossings, and logistics infrastructure were recommended by means of upgrading and applying planned maintenance.

Further, the solutions included building a dry port as a solution that would organize the transport from and to the port and logistics including functions that attempt to capture some proper solutions for further improvement. For the informational problems, the solutions recommended a setup of a computerized system for predicting transport, utilization of Electronic Data Interchange (EDI), the need for a comprehensive information database supervised by the Ministry of Transport, and linking of the port information system and the VTS by international standards-based IT systems that merges ports terminals with the transport stakeholders.

In this essence, the third chapter gave an example (as a case) of the benefits of integrating a new solution into the transport and logistics sector (Custom yard four). There was various benefits after launching this recent project i.e. containers dwell time has decreased from 15 days to 9 days, cost of handling goods decreased by around JOD 14 million, and full containers throughput increased by 5.5%.

3- To assess the best location of dry port in Jordan compared to other proposed locations.

In chapter four, a dry port as a possible solution was further discussed and explained by citing reliable researchers who supported the concept of building a dry port. The dry port would seemingly yield numerous benefits, which were presented in the same chapter to support and further validate the concept.

Importantly, the best location of a dry port in Jordan was pinpointed by using the center of gravity model. The gravity model took the twelve markets in Jordan (governorates) and their distance from each other and their demand of TEUs (import and export). This was a

very important step and it is considered the core of this study because it presents the right location of the sought dry port. The location would be close to the biggest markets taking into account other markets to minimize the total cost of transport.

Moreover, this step was necessary to give a solid proof to the Jordanian government about the right location of the dry port especially after the recent complications regarding the selection of a dry port location (there were four suggested dry port locations and other markets competed to have the dry port build in their territory). The best dry port location was in Amman, the capital city. This site would be more justified because Amman market could serve more than of 60% of the Jordanian markets, not only that but also all the main regional or national highways go through the city.

Further, in Amman, there are one industrial zone and one development zone in locations that best suit building a dry port, which offers a wide variety of privileges and facilitations to operators and investors, such as free taxing, government-owned land, roads and other important services.

To augment the finding of this study (Amman is the best location for building a dry port in Jordan), an analysis conducted that compared transport costs, distance and time saving of all the previously suggested locations (by the government) of dry ports and Amman. The analysis showed that Amman dry port saves distance, time and costs for almost all the market customers.

4- To set up recommended functionality and design of the dry port in Jordan.

After reviewing the literature and looking at the requirements of a dry port in terms of design and functionality, that is, to help square away most of the transport and logistics problems in Jordan, this study presented recommended functionality and design. Thus, the dry port needs to have a customs function to expedite and facilitate clearance procedures, as well as, logistics facilities, and information technologies.

The design has a railway terminal and yards for empty and full containers for import and export, gates, service facilities e.g. workshop and marshaling yards and other important services.

In conclusion, this research showed Jordan is on the doorstep of a makeover from a traditional transport to a developed logistics and transport sector; therefore, the dry port is a very vital step to smoothen this renovation. Therefore, having a dry port and a logistics sector integrated within or close by would lead to further optimization and improvement in competitiveness in the region. In brief, the dry port concept would be efficient if it were built in Amman; however, the dry port itself cannot resolve logistics and transport problems, but it provides better conditions for transport (multimodal) from and to the port of Aqaba, transfers the seaport workload to the dry port, and provides organized logistics solutions

## 5.2. Recommendations

There are some issues deemed necessary for the dry port success, it is highly recommended that the following issues are taken into account once the dry port is built:

- Fees that are paid in Aqaba for customs despite the fact that goods are not cleared over there need to be removed and the payment be due at the dry port
- No declaration is required in Aqaba; therefore, all declarations are at the dry port
- Secure transport of goods, especially general cargo, from Aqaba to Amman
- Maintenance of the road network that leads to the dry port
- Expedite the project of a railway network
- Continuity of having truck transport as a backup for train transport until it is proved that the rail transport is efficient and offers continuous and competitive services

## 5.3. Implication and further areas of research

The finding of this research, assessment of the best location of dry port in Jordan, can be inferred to other regions because the methodology utilized a center of gravity model and that model could be applied anywhere to have the best location that considers the cost of transport, distance and markets demand. In other words, the advantage is the knowledge of such technique. However, the solution as a dry port may not be a useful solution for other countries because it may not yield any benefits or sort out transport or logistics problems as it may do in Jordan.

This research has expanded the knowledge of the current problems in the transport and logistics in Jordan and offered various solutions to grasp the problems. Notably, the research was conducted without substantial limitation, but it was believed that there is nothing perfect, unless all ethical and empirical efforts are exerted to avoid and diminish any limitation to achieve the pursued objectives.

On the other hand, regarding further areas for research, the dry port concept could be more consolidated by utilizing quantitative approaches but also qualitative approaches and methods are important as the case of using questionnaires and interviews with all stakeholders i.e. port operators, MoT, trucking companies, customs, logistics companies, shipping lines, customers and investors to gather a more informative background about the need for the dry port, best design, operational and service requirement and other hidden facts and views.

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## Appendix A: Center of Gravity Model Calculations

## Background

Jordan intends to build a dry port, therefore, it is important to find the right location
It should be in a location with which the total transport cost is minimized.In the hinterland, there are 12 major markets (Governates) with mixed import and export traffics. The transportation cost is a flat rate of USD 2 per TEU per km.
The location of the facility is initially set to (x, y) = (0, 0).
Then the calculated x' and y' in the previous set will be used to calculate the new $d_n$.

| | |
|---|---|
| $d_n$ | The distance between the facility in question and location ($x$, $y$) |
| $D_n$ | Qunatity to be transported in and out per year (in FEU) |
| $F_n$ | Cost of shipping 1 TEU for one km between the facility inquestion and location $n$ |

$$d_n = \sqrt{(x-x_n)^2+(y-y_n)^2} \qquad TC = \sum_{n=1}^{k} d_n D_n F_n$$

$$x' = \frac{\sum_{n=1}^{k} \frac{D_n F_n x_n}{d_n}}{\sum_{n=1}^{k} \frac{D_n F_n}{d_n}} \qquad y' = \frac{\sum_{n=1}^{k} \frac{D_n F_n y_n}{d_n}}{\sum_{n=1}^{k} \frac{D_n F_n}{d_n}}$$

**Figure A1: Starting point calculations & First Iteration**

The locations in a coordinate and the startup calculations are as follows:

| | Coordinates | | Transport | Quantity in | **(1) start from (0,0)** | | | |
|---|---|---|---|---|---|---|---|---|
| | $x_n$ | $y_n$ | cost ($F_n$) | TEU ($D_n$) | $d_n$ | $D_nF_nx_n/d_n$ | $D_nF_ny_n/d_n$ | $D_nF_n/d_n$ |
| Aqaba | 8 | 20 | 2 | 15651 | **22** | 11625 | 29063 | 1453.2 |
| Ma'an | 82 | 87 | 2 | 11985 | **120** | 16441 | 17443 | 200.5 |
| Tafilah | 70 | 154 | 2 | 8009 | **169** | 6628 | 14582 | 94.7 |
| Karak | 77 | 190 | 2 | 26337 | **205** | 19784 | 48817 | 256.9 |
| Madaba | 85 | 244 | 2 | 15737 | **258** | 10354 | 29722 | 121.8 |
| Amman | 102 | 268 | 2 | 333343 | **287** | 237144 | 623084 | 2324.9 |
| Balqa | 80 | 278 | 2 | 40900 | **289** | 22622 | 78610 | 282.8 |
| Zarqa | 116 | 280 | 2 | 113530 | **303** | 86905 | 209771 | 749.2 |
| Jarash | 100 | 303 | 2 | 19718 | **319** | 12359 | 37449 | 123.6 |
| Mafraq | 130 | 310 | 2 | 45744 | 336.2 | 35380.9 | 84369.7 | 272.2 |
| Ajlun | 90 | 310 | 2 | 14646 | 322.8 | 8166.9 | 28130.5 | 90.7 |
| Irbid | 95 | 333 | 2 | 147240 | 346.3 | 80787.6 | 283181.6 | 850.4 |

**Figure A2: Second & Third Iterations**

| (2) | $d_n$ | $D_nF_nx_n/d_n$ | $D_nF_ny_n/d_n$ | $D_nF_n/d_n$ | (3) | $d_n$ | $D_nF_nx_n/d_n$ | $D_nF_ny_n/d_n$ | $D_nF_n/d_n$ |
|---|---|---|---|---|---|---|---|---|---|
| Aqaba | 210 | 1190 | 2975 | 149 | | 257 | 975 | 2436 | 122 |
| Karak | 131 | 15049 | 15967 | 184 | | 174 | 11296 | 11985 | 138 |
| Tafilah | 64 | 17400 | 38280 | 249 | | 110 | 10181 | 22398 | 145 |
| Karak | 28 | 145868 | 359935 | 1894 | | 74 | 55085 | 135925 | 715 |
| Madaba | 27 | 99814 | 286526 | 1174 | | 22 | 123539 | 354631 | 1453 |
| Amman | 55 | 1239893 | 3257759 | 12156 | | 8 | 8213563 | 21580735 | 80525 |
| Balqa | 60 | 108343 | 376491 | 1354 | | 26 | 247622 | 860486 | 3095 |
| Zarqa | 72 | 366555 | 884788 | 3160 | | 26 | 1018493 | 2458432 | 8780 |
| Jarash | 88 | 45005 | 136364 | 450 | | 43 | 91961 | 278641 | 920 |
| Mafraq | 105 | 113395 | 270404 | 872 | | 58 | 203353 | 484919 | 1564 |

**Figure A3: Fourth & Fifth Iterations**

| (4) | $d_n$ | $D_nF_nx_n/d_n$ | $D_nF_ny_n/d_n$ | $D_nF_n/d_n$ | (5) | $d_n$ | $D_nF_nx_n/d_n$ | $D_nF_ny_n/d_n$ | $D_nF_n/d_n$ |
|---|---|---|---|---|---|---|---|---|---|
| Aqaba | 266 | 941 | 2353 | 118 | | 265 | 943 | 2358 | 118 |
| Karak | 183 | 10748 | 11403 | 131 | | 182 | 10781 | 11439 | 131 |
| Tafilah | 119 | 9405 | 20692 | 134 | | 119 | 9452 | 20794 | 135 |
| Karak | 83 | 49031 | 120986 | 637 | | 82 | 49383 | 121853 | 641 |
| Madaba | 30 | 88522 | 254110 | 1041 | | 30 | 90255 | 259084 | 1062 |
| Amman | 1 | 82828156 | 217626920 | 812041 | | 0 | 294468484 | 773701508 | 2886946 |
| Balqa | 24 | 270355 | 939483 | 3379 | | 24 | 270424 | 939723 | 3380 |
| Zarqa | 18 | 1489137 | 3594468 | 12837 | | 18 | 1445734 | 3489703 | 12463 |
| Jarash | 34 | 114824 | 347917 | 1148 | | 35 | 113095 | 342679 | 1131 |
| Mafraq | 50 | 239479 | 571065 | 1842 | | 50 | 236700 | 564439 | 1821 |

**Figure A4: Sixth & Seventh Iterations**

| (6) | $d_n$ | $D_nF_nx_n/d_n$ | $D_nF_ny_n/d_n$ | $D_nF_n/d_n$ | (7) | $d_n$ | $D_nF_nx_n/d_n$ | $D_nF_ny_n/d_n$ | $D_nF_n/d_n$ |
|---|---|---|---|---|---|---|---|---|---|
| Aqaba | 265 | 944 | 2360 | 118 | | 265 | 944 | 2360 | 118 |
| Karak | 182 | 10790 | 11448 | 132 | | 182 | 10793 | 11451 | 132 |
| Tafilah | 118 | 9465 | 20823 | 135 | | 118 | 9468 | 20830 | 135 |
| Karak | 82 | 49481 | 122095 | 643 | | 82 | 49507 | 122161 | 643 |
| Madaba | 29 | 90769 | 260559 | 1068 | | 29 | 90910 | 260966 | 1070 |
| Amman | 0 | 1079930978 | 2837465708 | 10587559 | | 0 | 3998623602 | 10506187504 | 39202192 |
| Balqa | 24 | 270700 | 940684 | 3384 | | 24 | 270769 | 940921 | 3385 |
| Zarqa | 18 | 1433097 | 3459200 | 12354 | | 18 | 1429687 | 3450968 | 12325 |
| Jarash | 35 | 112656 | 341348 | 1127 | | 35 | 112536 | 340983 | 1125 |
| Mafraq | 50 | 235912 | 562559 | 1815 | | 50 | 235697 | 562047 | 1813 |

**Figure A5: Eighth & Ninth Iteration**

| (8) | $d_n$ | $D_nF_nx_n/d_n$ | $D_nF_ny_n/d_n$ | $D_nF_n/d_n$ | (9) | $d_n$ | $D_nF_nx_n/d_n$ | $D_nF_ny_n/d_n$ | $D_nF_n/d_n$ |
|---|---|---|---|---|---|---|---|---|---|
| Aqaba | 265 | 944 | 2360 | 118 | | 265 | 944 | 2360 | 118 |
| Karak | 182 | 10793 | 11452 | 132 | | 182 | 10794 | 11452 | 132 |
| Tafilah | 118 | 9469 | 20832 | 135 | | 118 | 9470 | 20833 | 135 |
| Karak | 82 | 49515 | 122179 | 643 | | 82 | 49517 | 122184 | 643 |
| Madaba | 29 | 90948 | 261076 | 1070 | | 29 | 90959 | 261105 | 1070 |
| Amman | 0 | 14844418422 | 39002981737 | 145533514 | | 0 | 55147198581 | 144896560978 | 540658810 |
| Balqa | 24 | 270786 | 940982 | 3385 | | 24 | 270791 | 940998 | 3385 |
| Zarqa | 18 | 1428769 | 3448752 | 12317 | | 18 | 1428522 | 3448156 | 12315 |
| Jarash | 35 | 112503 | 340884 | 1125 | | 35 | 112494 | 340857 | 1125 |
| Mafraq | 50 | 235639 | 561908 | 1813 | | 50 | 235623 | 561871 | 1812 |

**Figure A6: Tenth & Eleventh Iterations**

| (10) | $d_n$ | $D_nF_nx_n/d_n$ | $D_nF_ny_n/d_n$ | $D_nF_n/d_n$ | (11) | $d_n$ | $D_nF_nx_n/d_n$ | $D_nF_ny_n/d_n$ | $D_nF_n/d_n$ |
|---|---|---|---|---|---|---|---|---|---|
| Aqaba | 265 | 944 | 2360 | 118 | | 265 | 944 | 2360 | 118 |
| Karak | 182 | 10794 | 11452 | 132 | | 182 | 10794 | 11452 | 132 |
| Tafilah | 118 | 9470 | 20833 | 135 | | 118 | 9470 | 20833 | 135 |
| Karak | 82 | 49517 | 122185 | 643 | | 82 | 49517 | 122186 | 643 |
| Madaba | 29 | 90962 | 261113 | 1070 | | 29 | 90962 | 261115 | 1070 |
| Amman | 0 | 204911626022 | 538395252685 | 2008937510 | | 0 | 761433627304 | 2000629530563 | 7465035562 |
| Balqa | 24 | 270792 | 941003 | 3385 | | 24 | 270793 | 941004 | 3385 |
| Zarqa | 18 | 1428455 | 3447995 | 12314 | | 18 | 1428437 | 3447952 | 12314 |
| Jarash | 35 | 112492 | 340850 | 1125 | | 35 | 112491 | 340848 | 1125 |
| Mafraq | 50 | 235619 | 561861 | 1812 | | 50 | 235618 | 561858 | 1812 |

**Figure A7: Twelfth & Thirteenth Iteration**

| (12) | $d_n$ | $D_nF_nx_n/d_n$ | $D_nF_ny_n/d_n$ | $D_nF_n/d_n$ | (13) | $d_n$ | $D_nF_nx_n/d_n$ | $D_nF_ny_n/d_n$ | $D_nF_n/d_n$ |
|---|---|---|---|---|---|---|---|---|---|
| Aqaba | 265 | 944 | 2360 | 118 | | 265 | 944 | 2360 | 118 |
| Karak | 182 | 10794 | 11452 | 132 | | 182 | 10794 | 11452 | 132 |
| Tafilah | 118 | 9470 | 20833 | 135 | | 118 | 9470 | 20833 | 135 |
| Karak | 82 | 49517 | 122186 | 643 | | 82 | 49517 | 122186 | 643 |
| Madaba | 29 | 90963 | 261116 | 1070 | | 29 | 90963 | 261116 | 1070 |
| Amman | 0 | 2829459679382 | 7434266608573 | 27739800778 | | 0 | 10514208444954 | 27625567286743 | 103080474951 |
| Balqa | 24 | 270793 | 941004 | 3385 | | 24 | 270793 | 941004 | 3385 |
| Zarqa | 18 | 1428432 | 3447940 | 12314 | | 18 | 1428431 | 3447937 | 12314 |
| Jarash | 35 | 112491 | 340847 | 1125 | | 35 | 112491 | 340847 | 1125 |
| Mafraq | 50 | 235618 | 561858 | 1812 | | 50 | 235618 | 561857 | 1812 |

**Figure A8: Result of all Iterations**

| | (0) | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|---|
| $x'$ = | 0 | 80 | 99 | 102 | 102 | 102 | 102 | 102 | 102 |
| $y'$ = | 0 | 218 | 260 | 269 | 268 | 268 | 268 | 268 | 268 |
| | (9) | (10) | (11) | (12) | (13) | | | | |
| $x'$ = | 102 | 102 | 102 | 102 | 102 | | | | |
| $y'$ = | 268 | 268 | 268 | 268 | 268 | | | | |